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Molding the Packard, "Twin-Six" Motor Castings

Involved in the Production of the En-bloc Cylinder is Some Exceedingly Intricate Core Work Necessitating the Setting of 32 Cores

THE problems confronting the foundry superintendent of a modern automobile plant differ considerably from those encountered in the jobbing field. Such a shop is merely a unit in a great system and, therefore, it is not necessary to maintain elaborate sales and accounting departments. Furthermore, it is always possible to secure accurate time and cost data upon a fixed number of parts in spite of the fact that the castings produced vary widely in character and change materially from season to season. On the other hand, the machining and assembling departments demand a steady and uniform supply of complicated, accurately-finished, light castings. Also, production must be maintained in spite of difficulties that may arise and the foundry foreman must never forget that he is simply a link in the chain. The fierce competition in the automobile field, tending toward an engine and chassis of extreme lightness, power, freedom from vibration and elegance, necessarily has complicated the design of the castings.

These conditions have led to the development of a highly specialized type of foundry management, which may be studied to advantage in such an organization as that of the Packard Motor Car Co., Detroit. In normal times the Packard foundry is relied upon for practically all the castings used by the company in the production of its pleasure cars and commercial vehicles. At present, owing to the tremendous demand for heavy trucks, it has been found necessary to place considerable work in outside foundries, including the more important castings for the truck engine and transmission. Probably the most interesting job now handled in the company's own shop is the *en bloc* cylinder casting for the Pack-

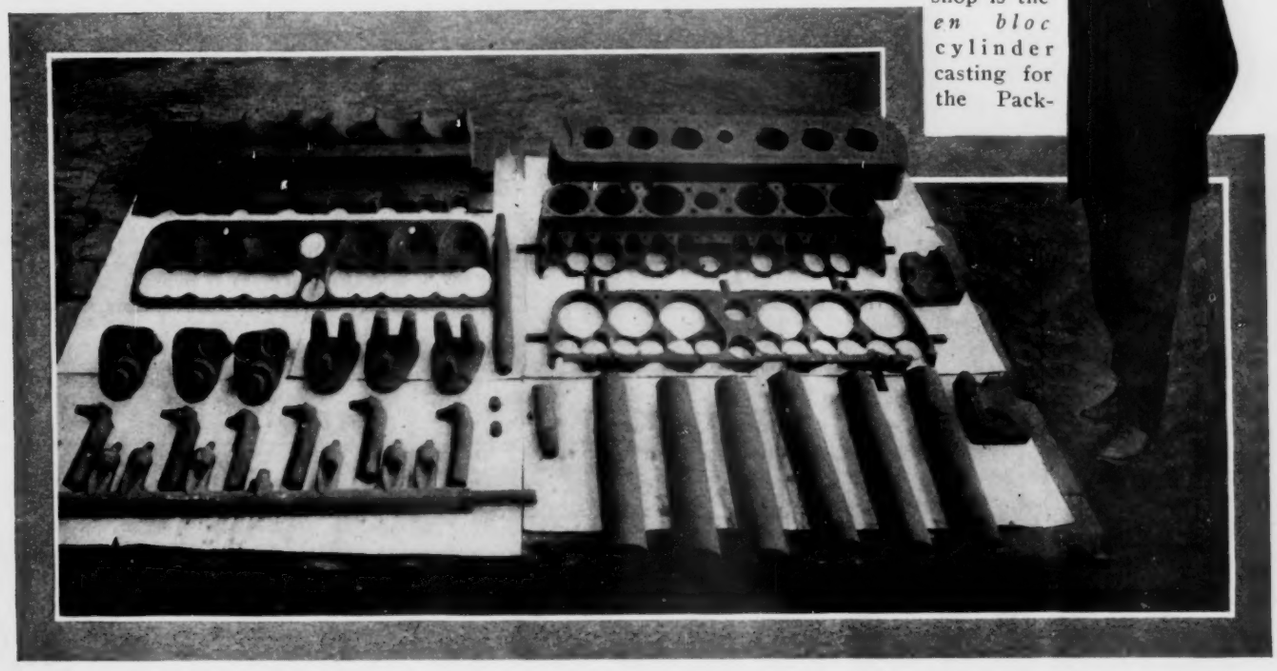

FIG. 1—CORES FOR THE PACKARD "TWIN-SIX" MOTOR—AT THE RIGHT IS EMIL B. HORNE, SUPERINTENDENT OF THE FOUNDRY, FORGE AND PATTERNMAKING DEPARTMENTS OF THE PACKARD MOTOR CAR CO.

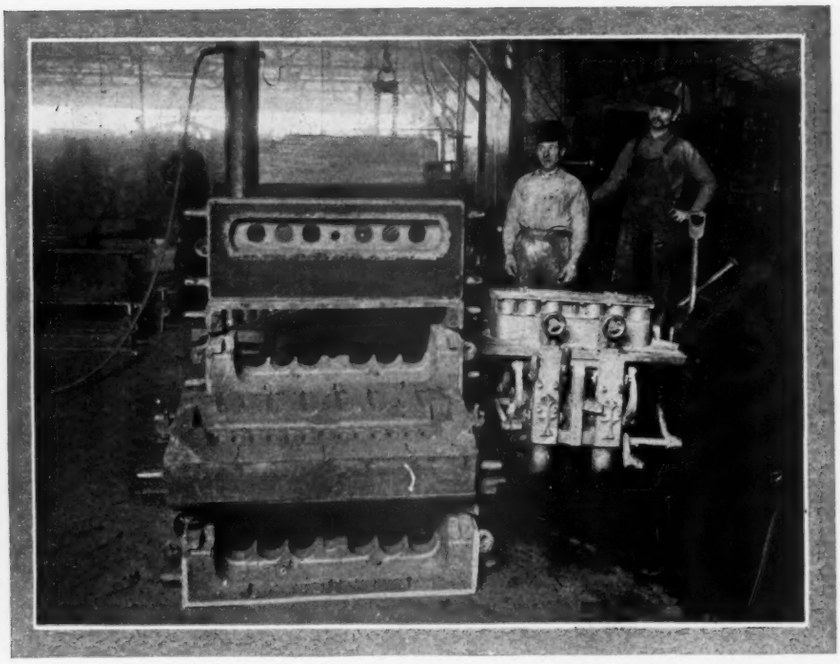

FIG. 2—MAKING CYLINDER MOLDS ON A POWER ROLL-OVER JARRING MACHINE

ard "twin-six" pleasure care engine. In the completed casting no less than 32 cores are utilized. About 125 complete cylinder sets are turned out daily. In addition, the iron foundry manufactures exhaust manifolds, pistons, fly wheels, gears and many other parts for the "twin-six" motor. For the principal engine castings a high grade semi-steel is employed. Jigs for the machine shop and other miscellaneous castings are made of gray iron. The aluminum and brass casting departments, located in the same building with the iron foundry, produce such parts as carburetors, crank cases, clutch housings, bonnet dash shelves and circulation pumps.

Use Continuous Methods

In order to facilitate uniform production, labor-saving, continuous methods have been devised. The details of the cylinder casting are particularly interesting. The patterns and core boxes are all made of cast iron and are carefully machined in the company's own pattern shop, situated immediately above the iron foundry. In this department, the metal flasks also are machined and the patterns mounted on boards ready for use. The pattern shop is 192 feet long and 44 feet wide, a large additional space being given over to pattern storage. In designing the shop special attention was given to the lighting facilities. Separate motor drives are installed for the wood and metal pattern departments. The equipment of the metal pattern division includes four lathes, two milling machines, three drill presses, a shaper, planer, boring mill, disc grinder, band saw and several emery wheels. The woodworking tools include two band saws, two circular combination rip and cross-cut saws, two joiners, three lathes, a thickness planer and a boring mill. All patterns used in the manufacture of castings made for the Packard company in its own or outside foundries are provided by this shop. The patterns are stored on steel racks, each containing seven shelves, 5 feet wide and 22 feet long. Among the patterns on hand are 16,000 of wood for various tools used throughout the works and more than 7,000 car part patterns of wood or metal for all Packard models ever made.

FIG. 3—SPECIAL SKIM GATE AND SPRUE

The molding sands, which are stored in bins at the rear of the building, are readily accessible from the main floor. Two large rotary sand mixing machines are situated in compartments next to the bins. A mixture of equal parts coarse and fine sand is used for the cylinders which are molded in three-part flasks. The jacketed portions are placed in the cope and cheek, the dome extending into the drag. The molding machines and assembling tables are arranged as shown in Fig. 2. The cope is rammed by hand in the ordinary manner, the pattern being mounted on a plate. The cheek is molded on a Tabor stripping-plate machine and is also hand-rammed. The drag is made on a Grimes shockless, power roll-over jarring machine manufactured by the Midland Machine Co., Detroit. The exhaust manifold is molded on a rock-over machine furnished by Henry E. Pridmore, Chicago, while the pistons are made on stripping plate machines installed by the International Machine Co., Chicago. The cores are made on a battery of International and Pridmore roll-over hand-jarring machines. All of the cylinder molds are dried over night. The core drying equipment includes three continuous ovens, as well as several others of the company's own make. The molding floor is served by a well-designed overhead trolley system.

Owing to the thinness of the cylinder walls, the multiciplicity of cores and the necessity for extreme accuracy, the gaging of the mold during its assembly is of special importance. Five

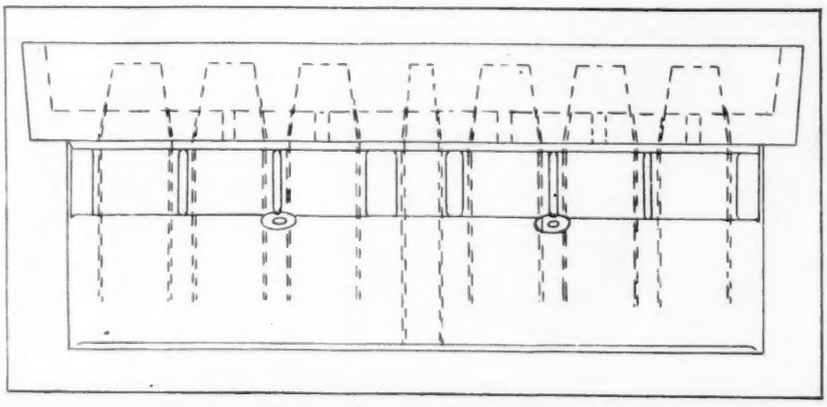

FIG. 4—SKETCH SHOWING METHOD OF GATING CYLINDER MOLD

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sets of gages, with seven pieces to a set, are used. They are made of cast iron and are provided with hardened steel faces. Each set includes a gage to test the height of the barrel core, a gage to set the dome jacket core to the proper height, a gage for adjusting the height of the combustion chamber cores, a gage for the height of the valve chamber cores, a gage for controlling the position of the gas intake cores, a gage for adjusting the height of the top jacket core and a gage to locate the barrel core prints in the top jacket. Filing gages for the center and top jackets also are used.

Assembling the Molds

To facilitate the assembly of the molds, continuous roller tables are employed, which permit handling the work with a minimum of manual exertion. A progressive system has been worked out for assembling the cores in the mold, the men working in gangs. The first operator cleans the empty drag by means of compressed air and sets the cores with the proper gages. The second operator removes the complete assembly of cores and starting at the bottom, lutes the joints with a molasses and flour mixture. The third operator puts the assembled core back in the mold and again gages each of the fitting points in order to check-up the previous work and insure absolute accuracy. The completed mold is then transported to the ovens for its final baking.

The molds are arranged for pouring as shown in Fig. 8. The melting equipment of the iron foundry includes three Newten cupolas furnished by the Northern Engineering Works, Detroit. They are 30, 60 and 72 inches in diameter inside of lining, respectively, and are rated at three, eight and 10 tons per hour. The stocks of pig iron, coke, limestone and scrap are stored in bins at the rear of the cupolas, as shown in Fig. 10. The two smaller cupolas are served from a single charging floor, the larger and newer one being provided with a separate platform. Each charging floor is equipped with a steam-operated elevator, the power for which is provided from a central boiler plant. The molds, including 125 cylinders, 45 manifolds, 150 pistons, 32 fly wheels and from 50 to 100 other parts, are poured once a day. In order to utilize the first part of the heat, thus avoiding pigging a large proportion of the duller iron, the fly wheels are poured first.

Two test bars are taken from each heat; one is sent to the company's central chemical laboratory and the other is tested in the foundry office. These bars are 1 inch square and 12 inches long, and are tested according to the standard specifications of the American Society for Testing Materials. Hardness tests also are made with a sclerescope. An average semi-steel bar of cylinder metal showed a transverse strength of 3,120 pounds, a hardness of 34 to 36, with ⅛-inch shrinkage and ¼-inch deflection.

The cupola charges are made up in special wheelbarrows and each load is carefully weighed on a platform scale located in the entry leading to the charging floor elevator. An employe is detailed for the sole purpose of checking the weights. The heats are tapped into a large bull ladle, the molds being poured by means of two-man hand ladles.

The method of gating the cylinder molds is illustrated in Fig. 4. Instead of being filled from the bottom, the metal is allowed to enter the molds through a narrow aperture surrounding the barrel cores. It is claimed that this equalizes the temperature throughout the casting, thus reducing shrinkage and cooling strains. Skim gates made of baked core sand, as illustrated in Fig. 3, are used in connection with all important castings.

The molds are shaken-out on the floor by a night gang, the castings being transported to the sand-blasting rooms at the rear of the iron foundry over a narrow gage track which bisects the main bay and transverses the entire length of the storage department. The used sand is transported to the mixing department in wheelbarrows, where it is screened by means of a Coombs gyratory riddle and remixed for further use.

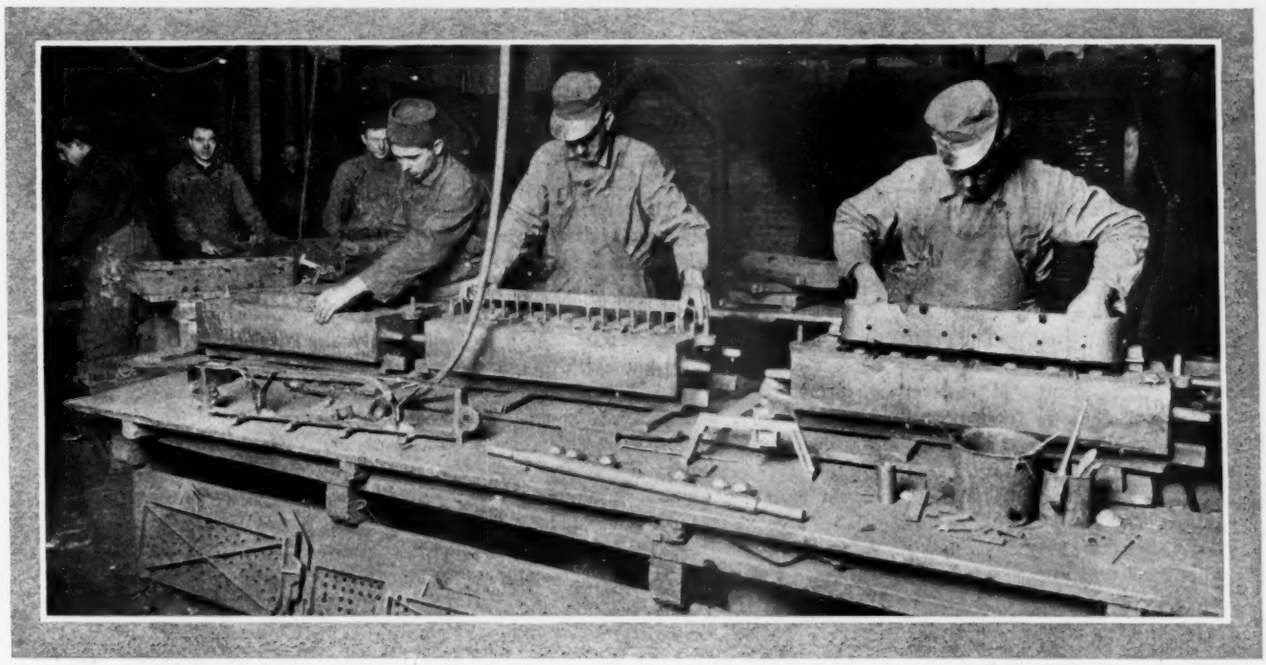


FIG. 5—ASSEMBLING AND GAGING CYLINDER MOLDS—THE FLASKS ARE MOVED FORWARD ON A ROLLER TABLE

Casting Inspection

After a preliminary brushing, the cylinder castings are remved to the cleaning, testing and inspection room immediately across the foundry. This department, shown in Fig. 9, is equipped with four large double emery grinders, one small grinder and four W. W. Sly tumbling barrels for smaller castings. By means of large exhaust fans connected to the tumbling barrels and hoods of the grinders, the cleaning

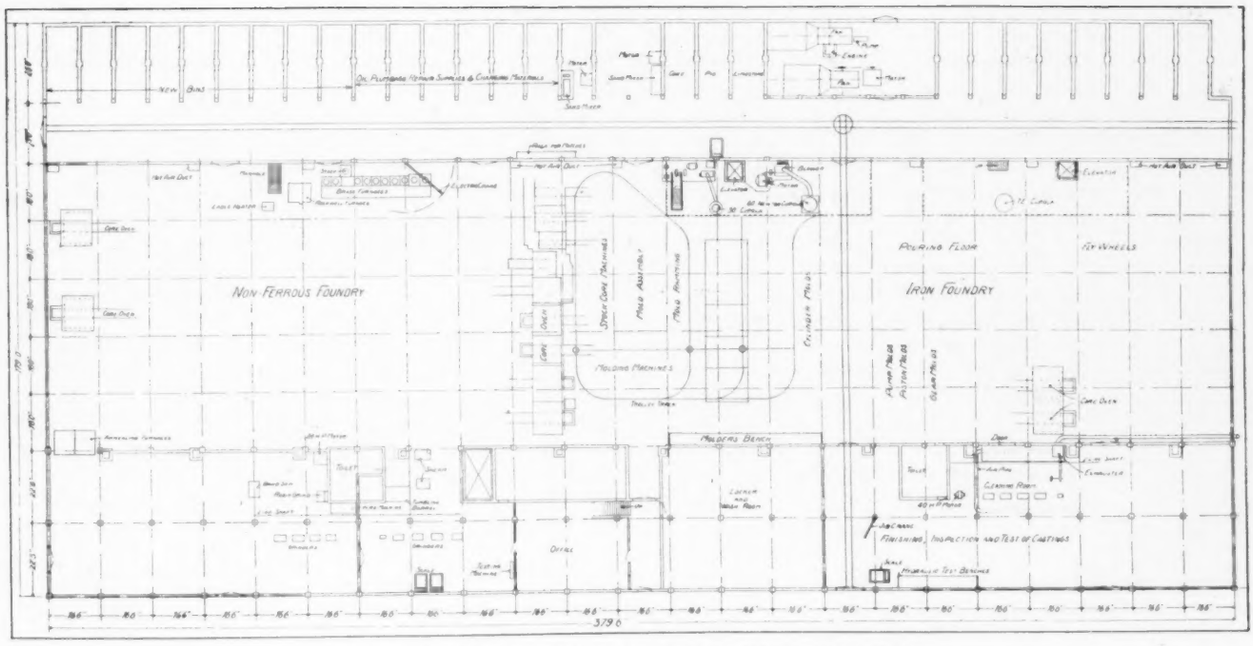


FIG. 6—GENERAL LAYOUT OF THE PACKARD FOUNDRY

room is kept free from dust. Eight pneumatic chippers also are provided, as well as an hydraulic pressure test system for the cylinders. Each cylinder casting is subjected to a 100-pound hydrostatic test in order to discover possible leakage. A sal-ammoniac solution is employed. The cylinders also are tested for soundness with hammers in the hands of experts who are able to detect any fundamental weakness by the ring of the metal. A small jib crane serves the testing benches and facilitates the handling of the heavy castings.

Other vital parts of the twin-six pleasure car power plant are made in the iron foundry, including water pumps and magneto housings, which are molded on match-plates, numerous gears, and various small parts which are molded on Tabor power squeezers.

Brass and Aluminum Foundry

Of almost equal importance are those accessories of the twin-six equipment manufactured in the brass and aluminum shop, which occupies about half of the foundry building. The output of the brass foundry is 75 tons per month and that of the aluminum foundry, approximately 63 tons. The non-ferrous department produces castings of such metals as brass, manganese-bronze, phosphor-bronze, Packard bronze, special bearing alloys, aluminum and magnalium. The latter alloy, composed of nickel, magnesium and aluminum, is employed in the carbureter and water pump. Among the brass parts are the motor-starter, gear shifter yoke, cam-shaft bracket, gas power pressure-pump body, motor auxiliary manifold cover and carburetor float. These parts are made with match-plates, using Tabor and Berkshire power squeezers.

Small cores for the non-ferrous castings are made by hand, others being made on International and Pridmore roll-over hand jarring machines.

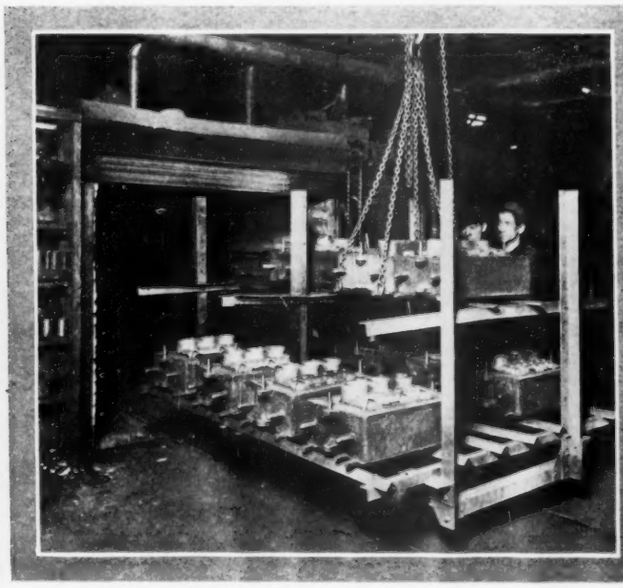


FIG. 7—LOADING ASSEMBLED MOLDS ON AN OVEN CAR PRELIMINARY TO BAKING

FIG. 8—GENERAL ARRANGEMENT OF MOLDS FOR POURING—THIS SHOWS THE OLDER PORTION OF THE FOUNDRY

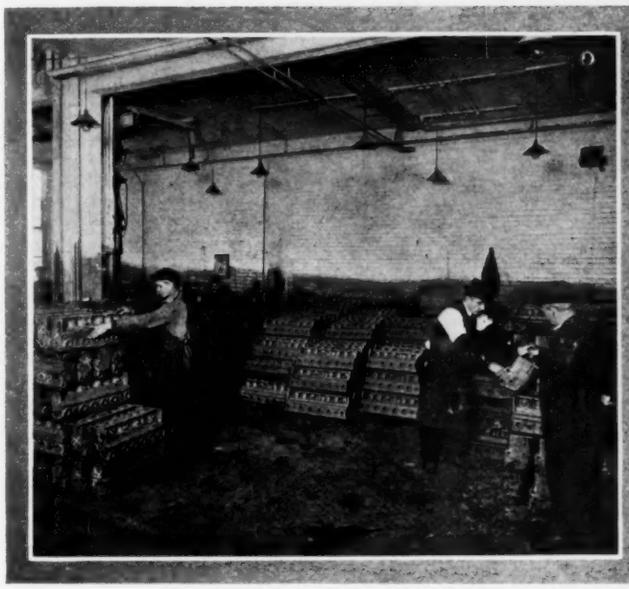


FIG. 9—CYLINDER CLEANING, FINISHING AND TESTING DEPARTMENT

FIG. 10—BINS FOR STORING MOLDING SAND, CORE SAND AND OTHER RAW MATERIALS

The aluminum department produces such parts as upper and lower sections of crank cases, transmission and clutch housings, gear cases, pumps, carbureters and bonnet dash shelves. Pridmore and International rock-over power squeezers are employed. In order to allow for the great contraction of the metal, soft cores are employed. Probably the most complicated casting made in this department is the water pump, for which nine cores are required.

In the manufacture of the aluminum clutch housings, the bottom half of the large central core is dry sand and the top half green sand. When the completed mold is shaken-out the green sand comes out readily, permitting easy access to the dry sand half of the core. The bottom half of the core is baked in order to give it sufficient strength to sustain the top half and resist the pressure of the molten metal. The Packard foundry was established in 1909, its original capacity being five tons a day. The first building was approximately 180 feet square, of concrete construction, with steel sash and brick facings. A saw tooth glass roof admits a maximum of light. The foundry is situated on the principal plant thoroughfare about a third of a mile to the rear of the main factory group and is supplied with raw materials by a spur from the Detroit Belt Line railway.

One hundred-foot additions to either end of the building make its present dimensions 380 x 180 feet. About 300 men are employed, divided equally between the iron and the non-ferrous departments. The iron foundry occupies a space of 90 x 214 feet and is separated by a battery of core ovens from the non-ferrous department, which covers an area 148½ x 90 feet. The floors are clay.

The office and wash rooms are at the front of the building, flanked on either side by the iron and the non-ferrous cleaning and testing departments. A space 44 feet wide, which traverses the entire length of the building at the rear, is occupied by the storage and air compressor departments, sand-mixing machinery and sand-blasting apparatus. The bins for sand and other supplies are 24 feet by 11 feet in width, and are massively constructed of reinforced concrete.

The melting equipment in the brass and aluminum foundry includes eight coke-fired furnaces turning out from five to seven 220-pound heats per day; one 220-pound, oil-fired furnace giving eight heats a day, and a Rockwell tilting furnace with a capacity of 500 pounds per heat also is being installed. Four new furnaces are also in the course of construction for melting aluminum. They are oil-fired and will handle 800 pounds at a charge. The miscellaneous equipment of the non-ferrous department includes core ovens, a ladle heater and an annealing furnace. About 20 molding machines are employed. An electrically-operated jib crane installed adjacent to the brass furnace battery facilities the handling of the metal. The equipment of the brass and aluminum cleaning and finishing department includes a water mill, a band saw, two Ferracute sprue cutters, 10 grinders, a Noble electromagnetic separator, a rosin grinder, a wire-cutting

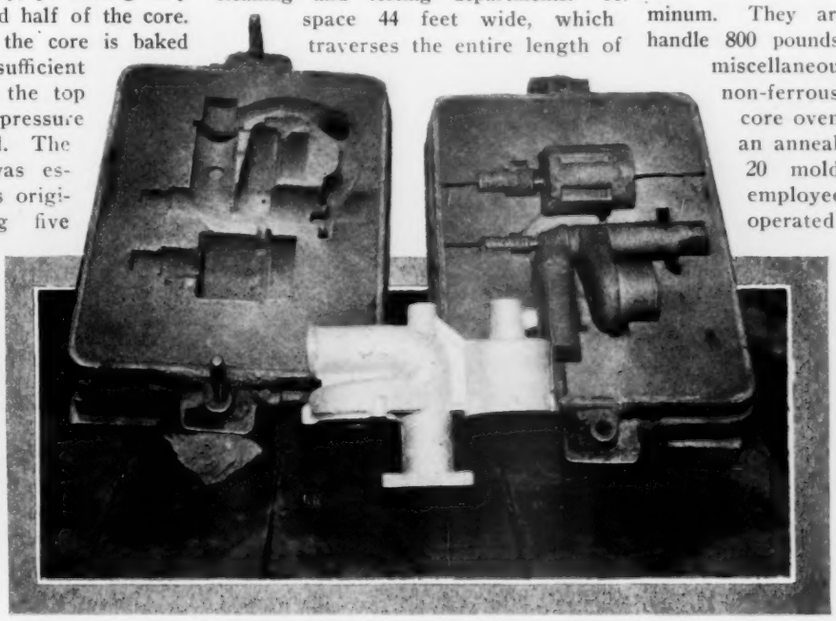


FIG. 11—MOLD FOR CARBURETOR CASTING

The carburetors are made of magnalium. This illustration shows both the cope and the drag, together with the finished casting. The cores have been assembled and set in the drag half of the mold

machine and a wet tumbling barrel. A Shepard trolley crane serves this department.

Unusually complete sanitary facilities are provided by a large, light, spacious central locker room and wash room, as well as several commodious lavatories conveniently situated in the building. Steam, electricity and gas are supplied to the building by means of a tunnel which traverses the entire plant, entering at the rear of the structure. Special attention has been paid to the ventilation, ducts for the admission of fresh, heated air being situated at frequent intervals.

Safety Methods in Use

The use of goggles and congress shoes is rigidly insisted upon. The ladles used for transporting metal from the cupolas to the molds are provided with spark deflectors. In general, an effort is made to bring the men to a realization of their responsibility toward themselves and their fellows in the maintenance of proper precautions.

As might be expected, the bookkeeping system is simpler than would be necessary for a large jobbing plant. An admirable method, nevertheless, has been worked out, so that capacity and production may go hand in hand.

The foundry office staff includes six clerks. As in other departments of the Packard company, shop orders are received from the central planning department through the purchasing department. Standard prices, based on accurate time studies, are set for all castings. Pig iron and other supplies are purchased through requisitions drawn on the purchasing department. The piece-work system is used in executing large orders, the molders being paid according to the number of accepted castings shipped; the coremakers are paid according to the number of perfect cores going into the ovens, a timekeeper being employed to count the cores for this purpose. The calculations are based upon a 9½-hour day.

The output of every machine, each molding floor, each bench molder and of the core room is carefully recorded and the capacity of the shop is definitely known. This information controls the operations of the foundry and enables the management to determine when to place orders for castings outside. By means of the production record the superintendent is able to keep a daily check on the various departments. Each part is given a separate column and it is thus possible to locate readily the cause of delay in the production of any casting.

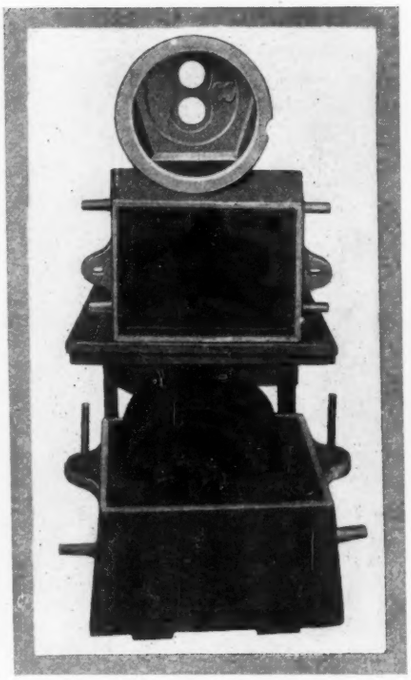


FIG. 12—AN INTERESTING CASTING, WITH ITS MOLD, USED IN THE PACKARD CAR

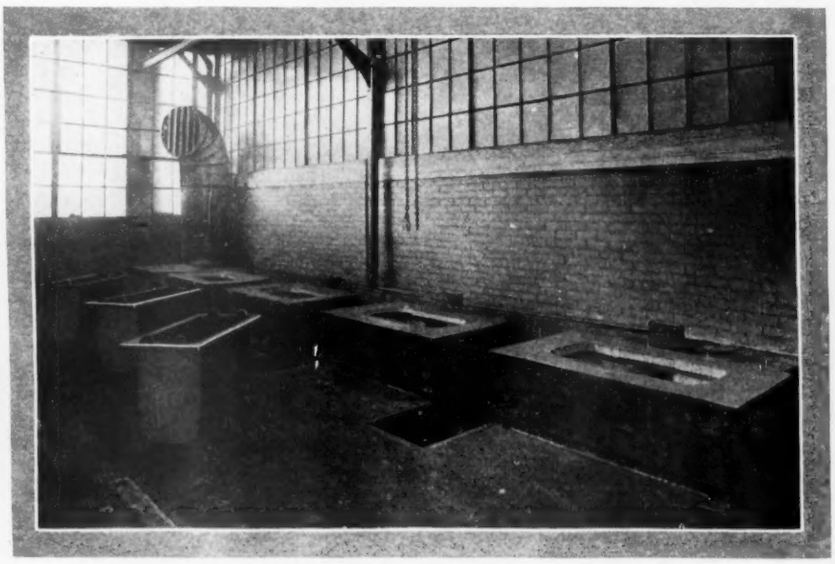


FIG. 13—INSTALLING CAST IRON POTS FOR MELTING ALUMINUM

The foundry, forge and patternmaking departments of the Packard Motor Car Co. are in charge of Emil B. Horne, superintendent, assisted by Ed. Whitmore, foreman. The pattern shop is under the supervision of R. M. Scott.

How to Copper-Coat Gray Iron Castings

Question.—What are the proper proportions of blue vitriol, nitric acid and water to impart a copper color to castings?

Answer.—The following proportions will give you the color required, but the process is very slow and certainly is not a practical method for commercial purposes: Blue vitriol, one pound, 10 ounces; nitric acid, one pound, four ounces; and water, one gallon. The color forms very slowly with any variation of these proportions, but if the castings are immersed in the correct solution, the copper coating is obtained quite rapidly and forms sufficiently heavy to allow scratch brushing. The casting should be smooth and clean before entering the dip. This method is rather antiquated and is not in general use.

We would suggest that you try a more practical method, which consists of placing in a 20-gallon stoneware crock or lead-lined tank, 18 gallons of clean water, to which is added slowly two gallons of hydrofluoric acid; only a small amount of acid should be added at a time and the solution should be stirred with a piece of wood. Heat is generated and the solution, when prepared, will become quite hot within a few minutes. It may then be used for dipping. To obtain the best results, the dip must be hot and in order to obtain the proper degree of heat, lead coils are used to supply steam. The advantage of hydrofluoric acid lies in the double action it produces, namely, the removal of sand and coloring the casting. If you do not desire to use the hydrofluoric acid, a good copper color may be obtained by using oil of vitriol in place of hydrofluoric acid. Use the same proportions and keep the solution hot. Cold dips are not economical and the casting should always be tumbled before being placed in the dipping solution.

The Lakey Foundry & Machine Co., Muskegon, Mich., advises that all contracts for construction work and equipment for its proposed addition have been placed. This company manufactures sawmill machinery and motor castings

A Few Problems Confronting British Foundrymen

Waste in Casting Production is an All-Important Factor, While the Shop Personnel Must Not Be Overlooked

By H Sherburn

THE war in which we are now engaged is raising many problems and gives additional emphasis to others which already confront us. One of the most striking features of the present conflict is the power of organization which both for war and industry has been so largely developed by the Germans, especially during the last quarter of a century. We British have been repeatedly reproached, of late years, for our neglect of this power in industry. The capture of branch after branch of industry by the Germans from our very hands has scarcely had the effect of thoroughly arousing us from our state of self-satisfaction.

Results of German Organization

The result of German organization in the field of war is—no doubt—bringing these things again before us with added force and we shall be wise to meet the challenge fearlessly—even after long neglect—and take advantage of all the experience which recent happenings has given us.

Among the important problems we have before us is that of waste and I wish to draw attention to some aspects of waste in foundry operations. The most important factor in the consideration of waste, in my opinion, is that of human energy, physical and mental, and while one may be accused of misapplying philosophy, we are compelled, on close thinking, to recognize that the psychological aspect of the question should receive full attention if the subject is to be adequately examined.

It is generally conceded that the standard of ability among molders today as craftsmen is lower than it was a generation ago, despite the fact that more castings are now being produced than ever before. The progress made, which is most pronounced from the point of view of output, has been chiefly obtained as a result of the application of mechanical methods to foundry practice. In contrast, however, we are developing a lower standard of mentality among the rank and file of the men who supply the human element in the process of castings production.

The main concern of the management is to keep down the cost of production, especially if engaged in a competitive industry which probably means cut prices coupled with heavy selling and establishment charges. The management often fails, however, to appreciate the point of view of the superintendent and the worker.

The foundry superintendent of today need not necessarily be a practical molder; his first qualification must be ability to get out the work. There is a vast difference between doing work and seeing that it is done. The person who, however, combines both qualities is more effective than the specialist in active direction. Incidentally the foundry superintendent may be a greater victim to a rigid system than those who work under his direction. His work must be mapped out for each day, if he has any idea of keeping ahead of it, and thus there is a tendency to direct all effort upon mechanical and routine lines. He makes sure of his castings by specializing his work, giving certain work to certain individuals and keeping the job with them.

Training of Molders

The inadequate facilities for the technical education of young molders is eloquent testimony to the failure to interest the young men in the industry. If the demand were made it would quickly be met by the educational authorities. One of the first steps toward improvement is the giving of a wider variation of work to the apprentices even at some little sacrifice in production; the immediate loss would be more than balanced at a later period. Isolated cases may be cited where imagination and breadth of vision have been brought to bear upon industrial methods and the result with good management has been not only equal economy in production, but a wider development of craftsmanship. It will have to be realized, however, by those in authority that positions of management are not easy berths, but carry with them responsibility for the comfort of the workers much of which can often be discharged with no further expense than a little sympathetic forethought. If the foundry is to take its deserved place in the scheme of industry, we must harness and develop the intellect at the same time as the physique of the craftsman. The combined experience properly classified, of an intelligent staff, added to the knowledge of the management should tend more rapidly to efficiency than all the efforts of one or two individuals, no matter how clever those personages may be.

Waste of Iron

So much for the human side. Let us now pass on to the consideration of other sources of waste, taking the question of iron as of greatest importance. There are two main directions in which wastage of iron may proceed:

1.—By the purchase of expensive brands unnecessarily.
2.—By excessive losses in melting.

On the first point there will be considerable difference of opinion as to what scope there is for saving. It is realized that in some cases the foundry foreman is often beaten down in price of finished castings so that he is compelled to procure the cheapest foundry irons marketed. The surprisingly good results attained under these conditions is often remarkable. On the other hand, we find that many foundries are producing castings at very good prices and upon which many of the most expensive brands of pig iron are used. There is also the other condition where the iron is bought for the foundry without consulting the man in charge who has then to make the best of what is given to him. It will be obvious that this latter method of securing supplies cannot be efficient, unless as is sometimes, but very rarely, the case, the foundry foreman has not much knowledge of his materials and the buyer has.

It is usual when the foundries are working on remunerative work that standard mixtures of metal, based upon experience, are obtained. An inherent conservatism often prevents

From an address delivered before the Lancashire (Eng.) branch of the British Foundrymen's Association.

further experiment, and unless the castings begin to develop faults it is probable that nothing will induce the man in charge to reconsider his mixture, even with a view to lowering the cost thereof. The use of high quality irons, in many cases, is largely a matter of sentiment and there is no doubt that they are often used when cheaper brands would be equally satisfactory. The term high quality iron is a strictly relative one, depending entirely upon what constitutes the common iron of the particular district. It is quite conceivable that in a district where highly phosphoric irons are rare that this class of metal which we regard as common iron, would be considered high quality.

Here, therefore, we have a possible source of waste if expensive irons are used unnecessarily, and it is for every founder, if he knows his work, to reflect upon the cost of his various mixtures and consider whether cheaper grades of pig iron cannot be more widely used, even to the entire exclusion of some of the more expensive brands now largely employed in foundry practice. Of course, if the foundryman is not conversant with the distinctive features of the various brands of iron beyond the very broad terms of strong, soft, chilling, fluid, etc., he cannot hope to adequately deal with the problem.

Analysis of Foundry Iron

Considerable waste is also caused by the lack of uniformity in foundry irons. It has been pointed out at our meetings in the past that owing to the iron and steel makers' demanding iron to analysis, the faulty iron which is produced at times finds its way to the foundries where the materials are much more rarely submitted to analysis. This condition will continue to obtain until some organized effort is made by the founding industry to alter it. Pending the attainment of this happy position, the founder is concerned in finding a palliative. By using a number of the standard common brands of iron in the mixtures instead of keeping to one or two it is possible to reduce the chance of trouble through lack of uniformity. Thus if one brand goes off in quality its influence upon the mixture will not be so serious if it is only one of a number as would be the case if only one or two brands were used in the charge.

Faulty design is doubtless largely responsible for the use of expensive irons. In this case they are used in order to withstand the strains set up as a result of irregularities of shape and thickness. The influence of the foundryman should never be relaxed in this matter and the designer should be gradually brought to appreciate the problems of the cooling of molten metal.

Uniformity of cooling and its influence upon regularity of crystallization are intimately related to the ultimate cost of castings and it has been stated and restated, and practically experienced by many of us, that the strength of castings is more dependent upon proper crystal structure of the metal than upon the chemical composition of the metal itself, within certain broad limits. Experience in light castings practice emphasizes the point very strongly. The position of runners in this class of work often means all the difference between sound castings and those which have such internal strains and stresses that the slightest shock will break them, if indeed they do not fracture themselves in cooling.

Loss in Melting

The other main source of iron loss, namely that which occurs during melting, is perhaps a little more complicated. In the first place it is evident that a considerable amount of material enters the cupola apart from the metal which runs out in the molten state, and carbon of the fuel which is converted into gases, with the evolution of heat, and passes off as such. There is the sand on the iron, the ash of the fuel which varies in amount according to the quality of coke used, and also the impurities of the flux.

There are many foundrymen who do not realize the chemical reactions taking place in the cupola. In fact it may be said that very little reliable information is available respecting the thermo-chemistry of iron melting in blast furnaces. Experience has, however, revealed certain facts which, if considered from a chemical point of view will improve our practice.

We know, for instance, that the process of melting iron under foundry conditions is accompanied by the production of a certain proportion of slag. The reason for slag formation and the different types of slag that may be produced under different conditions may not, however, enter our calculations, and so long as the iron comes down fairly satisfactorily, the question of iron losses in the slag is generally ignored.

Some foundries require steady melting throughout a defined period, others may require large quantities of iron at intervals, in one case very hot iron may be required throughout the blow, while another may want hot iron at one time and duller metal at another and so the cases might be multiplied. Efficiency, therefore, does not entirely consist in obtaining the largest melt of iron per unit of fuel; the more effective calculation is based upon the proportion of coke consumed to the weight of sound castings produced.

Reverting to the question of fluxing again, it is remarkable to note the difference of opinion in this matter. I have known foundries where it was considered economical to melt iron without the use of fluxes. It is conceivable that blast furnaces making pig iron can operate without the addition of fluxes in cases where the ore is of such a character as to contain the necessary proportions of acid and basic materials to produce a satisfactory slag free from iron. It is difficult, however, to understand how the simple melting of iron without the addition of fluxes can be regarded as an economical operation in view of the impurities introduced in the process. It is perhaps unfortunate that so little data are available on this subject. The foreign matter introduced accidentally into the cupola which is chiefly silica or sand, is converted into slag at the furnace temperature by combining with bases. If the base lime forms part of the charge the slag will be a silicate of lime. If the lime be in excess, the free lime will attack the lining of the cupola and form further slag. Should there be a shortage of lime the excess of silica will combine with some of the iron to form a silicate of iron slag. Hence the loss of iron in this direction. Thus it is more economical to produce slags high in lime than those in which iron is the principal base. The amount of lime will have to be determined for each case individually, depending upon the purity of the constituents of the charges.

Advantages of Limestone Flux

It is desirable to use limestone in the form of chippings as owing to the removal of the slag being fairly rapid the contact of the materials is not very prolonged; the chance of the whole of the lime combining is therefore much greater than when used in the larger form.

In repetition work considerable amounts of iron may be unnecessarily melted owing to runners being too heavy and large. In a large shop the reduction of an ounce or two in the weight of runners will materially reduce the amount of scrap produced. As a possible source of saving, therefore, the design and position of runners is of considerable importance.

Coming to the consideration of the materials used in conjunction with sand in foundry operations, we find that several of these substances are consumed in comparatively large quantities. Some of them may be supplied in an impure state if the user does not investigate them very closely and thus another possible source of waste opens. In the case of coal dust blacking and resin, we can reassure ourselves by means of simple combustion tests without the use of any special apparatus. All that is necessary is some kind of vessel in which a small, definite quantity may be burned and the residue, if any, be retained. It is obvious that the best samples will contain the least proportion of ash and by comparison of samples from time to time against one of known quality, a very fair idea will be obtained with little cost or trouble. These suggestions are intended mainly for the foundryman who is not equipped with a laboratory for chemical analysis; many members, of course, have ample means of testing these materials in a more delicate manner.

Continued progress in the craft of founding metals depends upon the adoption of scientific principles. This does not mean the introduction of a new and mysterious method of working; in many cases it may mean some modification of practice and in others it will amplify present methods.

Science Applied to Founding

Many of us are apt to misunderstand the meaning of the word science. We associate its application to foundry practice with the introduction of chemists having no actual foundry knowledge. There is equal danger of the practical man and the theoretical man being unscientific.

The practical man is guided by his experience which is based upon observation. He is scientific if he observes accurately and his practice follows natural and economic laws. It may be that intuition prompts certain operations, but if they follow the above laws they are scientific. The practical man is unscientific when he does not take an active interest in his work or if he allows preconceived ideas and personal prejudice to obscure his judgment.

On the other hand, the theoretical man is liable to be unscientific in other directions. He is chiefly guided in his investigations by his theoretical knowledge of chemical and physical laws, information on which is as yet in a very incomplete state. He may be led astray in his deductions by failing to consider some condition which has not revealed itself to him and could not, therefore, be taken into account. He is also likely to be a victim to his own preconceived ideas. Thus the liability to become unscientific does not lie all one way or another. Sympathetic co-operation will, however, make the way much clearer for both workers.

Foundries of the Early American Days

By Present Timer

SOME time ago there appeared in several trade papers a history of the early American foundries, which though interesting, did not seem quite complete and accurate. The writer has tried to get the most accurate information possible on the subject, and feels satisfied that it is as near the truth as records in possession of several historical societies warrant.

There are no records of founding in the earliest settlements, such as St. Augustine, Florida, 1565; Santa Fe, New Mexico, 1582; French settlements along the South Atlantic Coast, 1562-1564; Arcadia or Nova Scotia, 1605; Jamestown, 1607; Plymouth 1620; New Amsterdam, 1623; the three jewels of the New World, Lynn, 1629, Boston, 1630, or Salem the City of Witches, 1628.

An Historical Kettle

Records in possession of the Lynn Historical Society show that in 1643 Samuel Hudson of Lynn, Mass., either leased or granted a strip of land along the Saugus river, in the present town of Saugus, Mass., to Joseph Jenks, an English foundryman and blacksmith, to erect a shop to manufacture iron castings and forgings. The shop was erected in 1643 and the first job molded and cast consisted of a small kettle. It is now in the possession of the Lynn Historical Society having been presented by Joseph Jenks to Samuel Hudson, and handed down to a descendant of Hudson, one John Hudson, who in turn presented the kettle to the society.

It is a small, round casting, about 8 inches high, 6 inches wide at the bottom and flares out to about 9 inches at the center, tapering to about 4½ inches at the top. It has the conventional three legs the same as the pots in the early days; the handle is square wrought iron, and the cover is cast with a wrought iron ring for a handle.

In 1647, Jenks built a forge in connection with his foundry and it is on record that he made an order for shackles for a gang of pirates who intended to use them in their trade, but the authorities used them on the *gentlemen* themselves.

In 1652 he cast the dies for the first silver money coined in New England, the patterns having been designed by Mrs. Jenks.

In 1654, Jenks made the first fire engine in America, said engine being made for the Boston authorities.

The foundry was located on the banks of the Saugus river and derived power from the water as a fair sized lake was situated only about one-eighth mile from the works. The iron used was bog iron taken from the bogs near what is now called the Newburyport Turnpike, a road even in those early days leading to Salem.

The bog is about a mile from the site of the old works, and could be reached by boat or raft across the lake. About 1663 the charter or lease expired, and the works were discontinued, owing to some differences between the owners and the town. As near as could be learned the works burned down in 1673.

First American Foundry

Taunton, Mass., put in a claim some years ago as having the site of the first American foundry. I believe the reason the Saugus Works have been overlooked was because the owners and operators consisting of 20 men were known as the Hammersmiths, and so confused with blacksmiths and forgemen. They were called Hammersmiths not because of their trade, but from the town they came from, Hammersmith, England.

The first foundry in Taunton started in 1653 and continued in business until 1860 making anchors for its last product. Branches of the old Taunton works were started in other places, but have all ceased business.

Next in line as an early foundry centre is the town of Carver, Mass., in Plymouth county. Data of said foundry are unreliable, but the claim is made that fuel and iron were found close to the site of the works.

Pattern Plates for Reducing Operating Costs

How These Devices Are Used to Advantage in Mechanical Molding Operations in English Casting Plants

By D Dalrymple

AT THIS particular period in the history of iron founding, with competition unusually severe, it is necessary to adopt stringent measures to cheapen the cost of production. If in this connection, pattern plates are utilized effectively, together with molding machines, it will be found possible to reduce molding costs to a minimum and at the same time to improve the quality of the product.

As compared with the practice of molding with loose patterns, the employment of pattern plates offers great advantages. One of the chief advantages, of course, is that the molder is not required to make the joint or parting as this is already done on the plate. The position of the pattern with relation to the available flask space is determined by its attachment to the plate, and therefore it is not necessary to arrange it on a suitable support for ramming. In order to utilize the flask space to the fullest advantage the master pattern used in making the pattern plate must be arranged in the most suitable manner. Follow-boards are, of course, not required, since the plate itself forms a solid support for ramming the sand.

A further advantage is that all patterns on the plate, comprising perhaps a dozen or more, are drawn simultaneously from the finished mold with such accuracy that for the most part damage is avoided, and troublesome patching is eliminated. This affords an opportunity to entrust the work to unskilled workmen, instead of to highly paid molders.

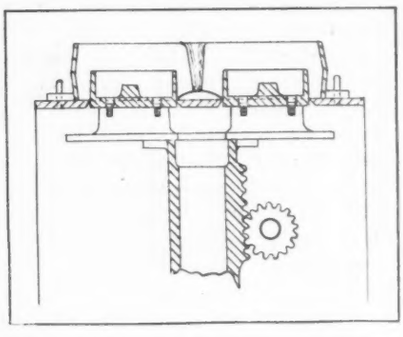


FIG. 1—SECTION OF STRIPPING PLATE

In some cases, the cost of making the pattern plates is considerable, and it follows that a large number of castings must be made in order to recoup this outlay. In view of the great advantages of the pattern plate, and the reliable manner in which the pattern is drawn from the mold, the idea of employing machines for this withdrawal in place of hand labor naturally suggests itself.

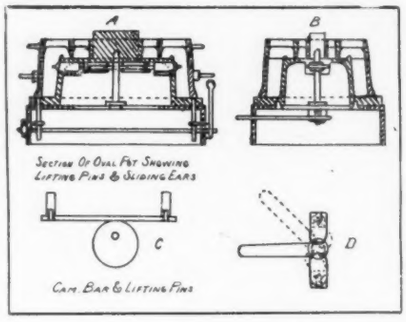


FIG. 2—LIFTING DEVICE

Tendency Toward Machine Molding

At the present time, there is an increasing tendency to transfer the labor from men to machines and it is imperative that no opportunity shall be missed for economizing effort. It is only where nearly automatic methods can be adopted that molding machines can make their best showing. Molding machines have now been developed to an extent not even dreamed of a few years ago.

Molding machines are particularly economical on repetition or specialized work and are exceptionally convenient for comparatively small work. For such work, a considerable saving compared with hand ramming is effected, while a perfectly vertical lift or draw of the pattern is secured, thus preventing broken molds and generally saving skilled labor, economizing time and increasing production.

In making pattern plates, the pattern is put on a wood board in the ordinary way, as if one were going to make castings from loose or shell patterns. In works where a large quantity of plates are made, men known as pattern molders are generally employed for this particular purpose. In many districts, pattern molding is a trade in which the men are trained from their boyhood, and after they have been on this particular work for some time, they soon become experts, saving the patternmaker a considerable amount of trouble, also effecting a saving in time. Usually, the pattern molder can be given the pattern or patterns to work from, without having them bedded on a board. Of course if master patterns are made in some of the white metal alloys, they would then be fitted on a block to prevent them being rammed out of shape. These patterns would be exactly as one would expect the castings to be from the plate, with the exception, of course, of shrinkage allowances. It is necessary to provide the pattern molder with parallel straight edges, so that he can make the parting of the mold true. After making the mold in the ordinary manner, he builds it up by a plate frame, which the patternmaker should provide. This frame is made to suit the size of the flask in which the plate is to be used.

There is no particular rule as to the thickness of plate frames. For flat plates for bench or stove work made on the floor, they are usually made of wood about 1-inch wide and 5/16-inch thick. For an irregular, jointed plate, the frame can be made much more easily in white metal by bending and soldering where necessary. When the mold is finished in the ordinary way, the plate frame is placed over the pattern, on the drag side, and sand is built up to the level of the top of the frame. If the flask were now closed its edges would be

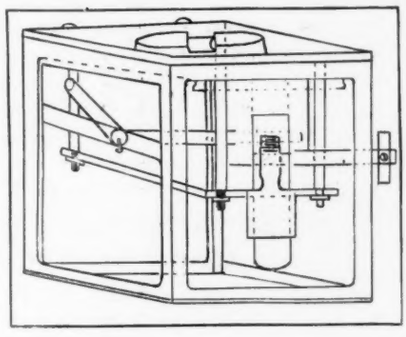


FIG. 3—STRIPPING PLATE MACHINE

Annual address of D. Dalrymple, president of the Birmingham, Eng., branch of the British Foundrymen's Association, at Birmingham, Oct. 23, 1915.

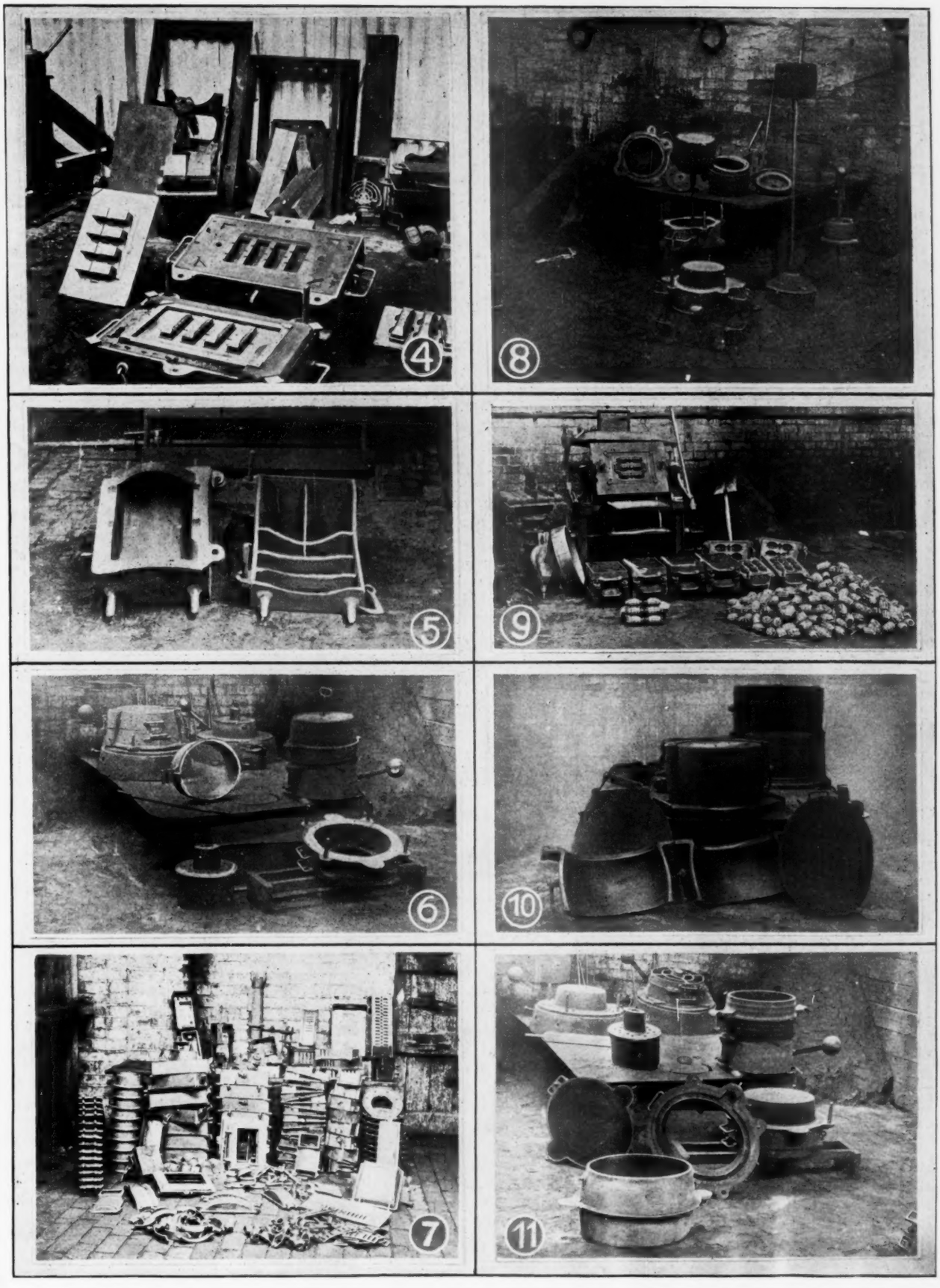


FIG. 4—METHOD OF MAKING PATTERN PLATES; FIG. 5—PLATE FOR A SMOKE CONSUMER; FIG. 6 — MODERN METHOD OF MAKING OVAL POTS; FIG. 7—CASTINGS MADE FROM PLATES ON MOLDING MACHINES; FIG. 8 —BENCH FOR HOLLOW WARE; FIG. 9—MAKING HAND GRENADES ON MOLDING MACHINES; FIG. 10—OLD METHOD OF MAKING OVAL POTS; FIG. 11—SAME PATTERN AS FIG. 6 WITH CORE IN POSITION

separated by the thickness of sand built-up and of course the mold would be crushed. To prevent this, cast iron pieces of the same thickness as the frame are placed on the corners of the box on the drag side before closing.

In Fig. 4, a pattern plate is shown in course of construction. The pattern is for a small electrical box. The parts in the flask form the cover, while at the left is the bottom of the electrical box. Four patterns are shown in the flask. At the right, are the loose patterns drawn from the mold. The plate is made up partly around the frame, and thickness pieces are placed on the corners of the flask. The pieces are the same thickness as the frame and prevent the mold from being crushed when the two parts are closed, in the manner previously described. The usual method of making pattern plates is to mold a master pattern in a flask large enough to take the size of plate required, allowing also for the gates, in cases where the plate is cast with

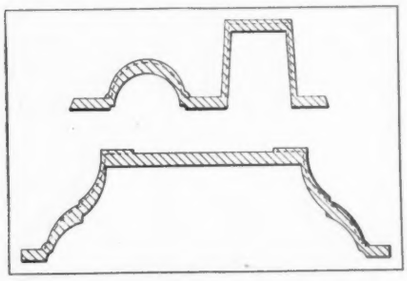


FIG. 12—SECTION THROUGH CAST IRON PLATE

runners on the outside edge. If the plate is cast on top with drop gates, a large flask will not be required. It is advisable to cast all the runners on pattern plates. A saving of time is effected if the work is done in this manner and it is very important that the runners should be well shaped and clean cut.

Another important matter in making plates is the facing sand, which should be well ground and tough. Also the mold should be skin dried, more particularly with large plates, so as to prevent any sharp projections of sand from being washed away with the flow of the metal when casting. It is important to note that the parting does not meet at any part of the mold, except around the outside, where it is built up with the frame.

It is advisable to have the pattern plate sufficiently large to project 1 inch all around beyond the flask, in which the plates will be used. This arrangement allows the molder to rap the plate easily without striking the flask and loosening the mold. It is well to keep flasks specially for making plates; they should have machined joints and turned pins, true and upright, and also should be well cottered in order to prevent the slightest strain.

In making pattern plates of cast iron care should be taken to avoid chilling the edges. The usual method is to place the flask on edge as soon as the iron is properly set, and then strip the sand away from the center of the casting, so as to allow it to cool evenly. This is necessary because the center is much heavier than the outside of the plate, owing to the combined thickness of the frame and the pattern. In exposing plates in this way, judgment must be used. I have had occasion to make over plates several times before getting them sufficiently true to make satisfactory castings. This applies particularly to very large plates.

Handling Difficult Jobs

When making plates for work that experience has shown will give trouble with fracture and bending, it is advisable to test the castings carefully by first making samples from the master pattern and observing how they turn out. This furnishes a good idea of the alterations necessary in the master pattern, before making the plate and thus saves the expense of making over the plate several times before getting the castings true.

Fig. 22 shows an ordinary pattern with a two-part flask, and a flat plate for the bottom. Two pins are mounted in the plate to fit the bottom part of the flask and three feet are cast on the under side to raise it off the floor. It has also a hole in the center to leave room for easy venting.

In molding, the inside of the pattern is filled up with sand and turned over onto the plate. The bottom part of the flask is then put on and the mold finished in the ordinary manner. It will be observed that there is no sand between the edge of the pattern and the bottom plate. A great many articles can be made in this simple way. It is more than 36 years since I first saw the method at work, and plate molding was not much in use at that time. This particular system is extensively employed at present, especially in Scotland.

For work involving deep, straight draws, such as fuse boxes for electrical work, a great saving will be effected through the use of molding machines. The plates are made in the ordinary way, but are made much thicker owing to their being forced to stand the strain of the squeezer board, etc. For other work, such as small pieces of irregular pipe, gas stove burners, and work in which it is possible to get a flat joint, instead of making the plate complete, especially if only a small number of castings is required, the better way is to have flat plates made to suit the machines, and have them machined true on both sides. The half pattern is then mounted on either side. These plates are easily removable and can be used for other similar work. Of course, wood boards would serve the same purpose as cast iron plates, where only a few castings are required, but they involve constant trouble due to warping, etc., and also the flask will not bed down upon them properly. It is much better to keep a few iron plates on hand, already machined, so that they can be used as required.

Fig. 12 illustrates cast iron plates of a kind which have given me considerable trouble. It will be observed that they are very irregular in thick-

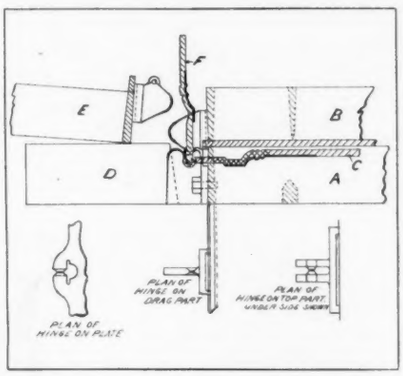


FIG. 13—SECTION THROUGH LARGE FLASK AND PATTERN PLATE

ness and are inclined to draw or sink very badly in the square corners. This causes considerable difficulty and also involves additional time patching with solder, iron cement, etc. Fig. 12 shows the section through a plate, the dotted line indicating the casting, showing the extra metal necessitated in making the plate. It will be seen that the plate is ½-inch thick. By raising the top part of the box to get that thickness, one obtains only a very little extra thickness from the pattern on the deep sides, because, the flask is raised perpendicularly, the full thickness of the plate is secured only on the flat surfaces, thereby causing the irregularity in the plate. Some time ago, I started making plates of a similar description in white metal instead of cast iron. This saved most of the contraction, and did away with a great deal of unnecessary work. It is possible also to clean up the white metal pattern better than one made in cast iron. However, in the use of white metal

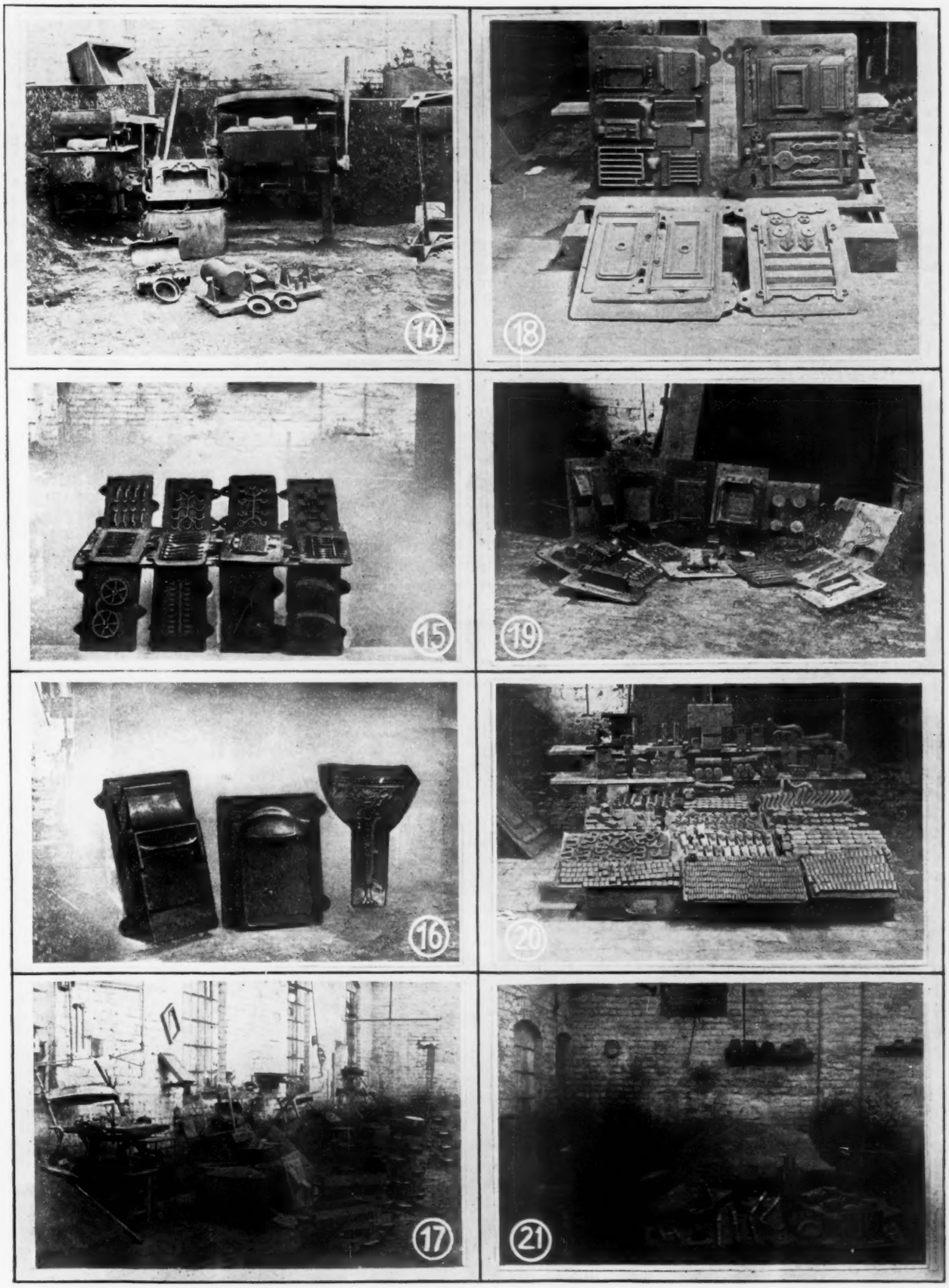


FIG. 14—MOLDING MACHINES FOR LIGHT WORK; FIG. 15—SMALL PLATES FOR BENCH OR SNAP FLASK WORK; FIG. 16—IRREGULAR JOINTED PLATES; FIG. 17—SAUCEPAN MADE ON MOLDING MACHINE; FIG. 18—PLATES FOR STOVE WORK FOR FLOOR MOLDING; FIG. 19—PATTERN PLATES FOR USE ON MOLDING MACHINES; FIG. 20—SMALL CORES USED WITH CASTINGS MADE ON MOLDING MACHINES; FIG. 21—SMALL PATTERNS IN HALVES FOR ATTACHING TO PLAIN PLATES

for a pattern plate, it is necessary to be more careful, in order that one may be sure the rammer does not get too near it.

Fig. 23 illustrates some features of a very particular job involving the use of patterns partly jointed on both sides, similar to lamp brackets. A good job can be secured by making the patterns in halves and doweling them together so as to properly finish the joint. To obtain a plain plate, mold one of the halves of the pattern in the ordinary way, making the joint properly and keeping it true and out of twist. Then ram up the top and place a wooden frame between the two parts of the flask. The frame should be the same thickness desired in the plate. Having secured this, fill the space left vacant by the thickness of the frame with plaster. In this way, the plate exactly matches the joint of the patterns. A cast plate is then made from the plaster and mounted on the pattern in the ordinary way. A very good job can be secured in this way, at perhaps a slightly increased cost.

Fig. 15 shows a group of small plates for bench or snap flask work, all being perfectly flat. Fig. 18 shows a group of plates for stove work for floor molding. These also are very flat and simple to mold. Fig. 16 shows a group of irregular jointed plates, for electric fire-fronts and table legs. These plates require special flasks made to suit the irregular joint of the plates.

Plates for Smoke Consumers

Fig. 5 exhibits another style of plate, used in making smoke consumers. It will be observed that the pattern plate is lying on the top part of the flask, and that the circular part of the top is loose on the plate and is fitted in position with two pins. In molding, ram up the inside, and make the joint across and around the circular part. Then ram up the drag or bottom part in the ordinary way, part off the drag, and draw away the loose circular part; close on the drag again and roll over the complete flask. Then part off the top and draw the plate.

Fig. 14 shows a group of molding machines for small light work. They are fitted with a squeezing and turnover mechanism and a lifting table for drawing the flask away from the pattern. The flasks are rounded so as to hold the sand better. Fig. 19 exhibits a group of plates used on the molding machines previously described. Fig. 20 shows a group of small cores for use in connection with plain plates in the manner already explained. These small cores are used in molds made on molding machines.

Fig. 13 shows a part section through a large flask and pattern plate. For convenience, the two parts of the flask are hinged together, and the pattern plate is worked in the same hinge. *A* shows the drag or bottom part of the box, *B* the top part, while *C* is the pattern plate of a large mantle register front. The hinges on the plate, as shown on the plan, work in

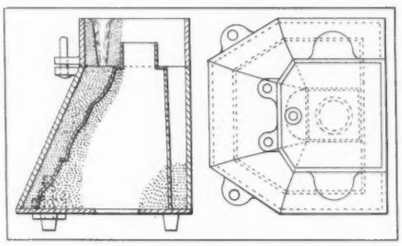


FIG. 22—PATTERN WITH MOLDING BOX IN TWO PARTS

the hinges on the drag, and the hinge on the top part of the flask fits on the top of the plate. At *E* is shown the top part of the flask hinged back, with the edge lying on the skid *D*. The top of the flask is clear of the plate. The plate is shown at *F*, hinged-up ready to be drawn out, thus bringing the parts together.

Fig. 1 is a section of a stripping-plate. This equipment has been in use for some time. The pattern, which is mounted on a bed-plate, projects upward into a half-flask through the stripping plate, which corresponds accurately to the pattern's contour. The pattern, necessarily, is made higher than the depth of the mold by an amount equal to the thickness of the stripping-plate. The compressed sand mold is separated from the pat-

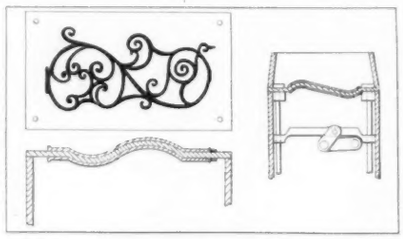


FIG. 23—SHOWING HOW PARTICULAR WORK IS HANDLED

tern by lowering the latter with its table from the flask, through the stationary stripping-plate.

In this way, the portions of sand adjacent to the descending surfaces of the pattern, which are more liable to tear, are supported by the edges of the stripping-plate. These edges coincide with those of the pattern, and thus protect the mold from breakage, so that after the pattern has been completely withdrawn, the flask can be lifted without any particular care. This describes the ordinary form of stripping-plate.

Fig. 3 shows a complete stripping-plate machine provided with a lever arrangement. It is so constructed that when one lowers the pattern down through the stripping-plate, the ratchet interlocks and lifts the flask away from the bed-plate by means of the spindles shown in the illustration. In certain difficult cases, a combination of turn-over and stripping-plate is used. After the sand has been rammed, the flask is turned over to an angle of 180 degrees along with the pattern plate. The flask is then lowered. The stripping-plate which is lowered at the same time, rests on the upper surface of the flask. Of course, instead of proceeding in this way, the pattern could be drawn up through the stripping-plate.

Making stripping-plates is expensive when the complicated outlines of patterns must be copied exactly. A simple and cheaper plan than that of copying the outline exactly on the plate, is to make the latter with an opening somewhat larger than the pattern, place the latter in position inside the opening, and fill up the space by running in a fusible metal; after it has solidified the opening will correspond exactly to the outlines of the pattern.

Making Utensils

Fig. 8 shows a hollow-ware bench. It will be seen that the mold is made up partly on a plate or block, with the bottom part of the flask rammed up and in position, ready to be drawn up over the core already fixed in the stand. The portion of the mold on the floor shows the core in position, while the top part is on the bench ready for closing.

Fig. 10 illustrates a rather old method of making an oval pot. The pot is made from a block pattern, with the plate extending through the center of the oval. On the bench, the core is shown with one-half of the flask in position, while the other half is lying on the top of the pattern ready to be set in place. In front is the top part showing the two drop gates. The pot is cast on the bottom. The two halves of the core box are shown in front.

Fig. 6 shows a more modern method of making an oval pot. In this case, the pattern is in two halves, top and bottom. The bottom part of the pattern is shown on the bench, with the flask rammed up and placed on the floor. The core is ready to be placed in the bottom. A lever is attached to the pattern to throw the

core out of the flask and so prevent a bad lift. The same arrangement is used on the top and bottom parts of the pattern to enable the flask to be thrown up, as shown in the top part on the bench. In front of the bench is the top part of the core box, while on the floor is the device for carrying the core. The hook in the core is used for transferring it into position.

Fig. 11 shows the same pattern with the core in position. In front is shown the cheek of the flask drawn away from the pattern. On the side is the top part showing the drop gates and the runners. The casting is run from the side at the center and not from the bottom. This is an improvement on the old method of casting from the bottom, with large, flat gates. The runners go around the casting, but on the inner edge where the metal enters the mold they are tapered off to a knife edge.

The castings poured in this manner turn out very clean. These castings are machined inside to make them perfectly clean and ready for coating with tin or enamel. In front is shown a casting with the runner still on, while on the bench in front is the device for carrying the core. The top part of the core corresponds exactly to the corresponding part on the pattern, while the bottom of the flask fits the corresponding part of the core. This makes it impossible to put the core in the mold the wrong way.

Pattern Lifting Device

Fig. 2 is a sectional view of a lifting arrangement for patterns and flasks. In this illustration, *A* shows the lifting pins and sliding ears; *B* shows the reverse section, illustrating how, by reversing the lever shown at *D*, the ears are withdrawn into the inside of the pattern enabling the flask to be struck off; *C* shows the cam, bar and lifting pins. By pulling the handle shown in *A* the flask is raised from the pattern.

Fig. 17 shows a saucepan made from a plate on a molding machine. Two machines are shown side by side with the halves of two patterns on each. One machine could be used, but in this case it is a question of quantity. In front is shown one part of the flask; the other part is rammed up and raised from the pattern by means of the lever arrangement previously described. The core box is shown on the floor in front, with the core ready to be set in the mold. Alongside is shown the device for carrying the core. The small plug cores are shown in front. These cores are not dried, but are made of green sand.

Fig. 9 shows hand grenades being made from a plate on a molding machine. A half pattern is mounted on each side of the plain plate. The two castings are being made with one core, the latter being balanced in the center print on what was formerly called the "string" principle. Six castings are being made in one flask, three cores being employed for the purpose.

Fig. 7 shows a few of the different varieties of castings produced from plates on molding machines.

The Modern Foundry Advance

By Richard Moldenke

ONE of the most fascinating studies is that of the history of iron founding. In digging up the old records of iron-making, and separating out that which is of interest to the foundryman one can trace the development of the industry and its spread from one country to another, notwithstanding the secrecy that surrounded individual effort in days gone by. The links in the chain of events were forged slowly and entirely out of comparison with the rush of modern development.

Cast iron may be considered a rather accidental and highly undesirable adjunct to the iron-making processes of ancient times. Well-known in Japan and Greece at the beginning of the Christian era, the first recorded example of pig iron making harks back to about 1300 A. D., in Westphalia, Germany. Sussex, Eng., followed this lead about 50 years later, when the primitive furnaces were used to produce blooms of wrought iron direct from the ore with charcoal fuel, occasionally yielding molten iron. This was of white fracture owing to the high manganese content and the workmen producing it accidentally were heavily fined therefor. When, however, it was found that such metal could be cast into cannon balls there came the dawn of a new industry. Furnaces were enlarged and artificial blast introduced. They were run alternately for blooms and direct castings, cannon and shot being the only objects cast in those days. The oldest German gun dates from 1414, and that of England, about 1516. Charcoal was the fuel used exclusively until Dud Dudley substituted coke of a kind, in 1619, in his own iron-making establishment. The real introduction of coke commercially, however, falls to the credit of Abraham Darby, in 1730.

An early book on iron-making, preserved in the library of the famous Berlin Armory, dated 1454, describes the furnace then used as having a chimney over the hearth for better charging of ore and charcoal in layers, this chimney having been capped by a *Kuppel* or cupola, from which our modern designation is derived.

As the art of molding was well-known at the time iron came into use, having advanced materially since the Bronze Age—the lost wax and loam molding processes having been thoroughly understood—it can be said that all the iron foundry can show up to the year 1500 is the use of *off* heats cast into guns of uncertain quality and molded probably as good as could be done today. With the year 1500 came the advent of the cast iron stove, the making of which spread over Europe quickly, and with it came an extension of iron-making to practically all countries having iron ore within their confines.

The casting of the comparatively heavy plates making up a stove meant open-sand work, and if this did not originate green-sand molding, it at least opened up a field for this class of skilled labor. The use of flasks came after this, the more modern development being credited to the aforesaid Abraham Darby, in 1709. Necessarily, the development of the stove, with its biblical ornamentation, and the growing tonnage of the casting industry meant greater attention to patternmaking. At the beginning of the eighteenth century the putting together of patterns from collections of ornamental dies of wood mounted upon boards and pressed into the sand had ceased, and patterns were made of one piece and highly finished. The beginning of the nineteenth century saw them of metal and nicely polished.

So that when the cupola came into existence in the early days of the

From a paper presented at the Atlantic City meeting of the American Foundrymen's Association.

eighteenth century, when a Frenchman conceived the idea of remelting pig iron in a separate shaft furnace instead of the regular blast furnace—and thus brought the foundry into being as a distinct industry—there existed probably everything essentially necessary that we have in our foundries today; less efficient and on a much smaller scale, it is true, but able to turn out first class work. The fact that castings made 100 years ago are successfully used today would prove this, and the reason for the remarkable modern foundry advance is to be looked for not so much in the castings shipped from a foundry plant, as in the thousand and one details of equipment and management from raw material production to the last of the finishing processes.

The Aid of Science

Practice has called in science to aid it, and between the two a world of accomplishment has resulted. So long as cannon did not burst during the first dozen discharges, and stoves did not crack when the first fire was lit, no one worried about the metal in them. The irregularities of the blast furnace may have bothered the furnaceman, but his customer did not know this. Dud Dudley distinguished gray, mottled and white iron, and undoubtedly suffered from this division in making his wrought iron therefrom afterwards, but if the kettle made for the housewife did not break she was satisfied. With the advent of the steam engine, however, and captains of industry who had to be shown why castings would break under this altogether different usage, as their own pockets, and not that of nations were concerned, things began to change and more reliable results were necessary. Hence, the remelting of pig iron which had been selected by its fracture as being of as nearly uniform a structure and suitability as possible. To the eventual unreliability of this method of judging iron, after the requirements of the machine shop, testing room and service demands became more stringent, and the blast furnaces had been crowded in capacity to the detriment of quality, do we owe the modern foundry advance forced upon the industry and ably developed by its pioneers in this departure.

Rarely has an industry been revolutionized in its methods and accomplishment as quickly as that of the foundry. Most of us remember the time when the foundry foreman practically ran the business. He made prices, bought pig and scrap, and oftentimes had to put up the more difficult molds. On the cupola platform the melter charged pig, scrap and anthracite indiscriminately though fairly well proportioned, as his results ordinarily came out well. It is but 32 years ago that the writer, while studying at one of the world-famous scientific schools, remembers the foundry discussed in a few brief lectures, and in no connection whatever with the chemistry of iron. Contrasted with today, what a mighty change has taken place, when even our foundry foremen calculate mixtures and argue over the second decimal place.

A summary of the modern foundry advances, as enumerated by the author in a book now in preparation, follows:

1.—The change in the valuation of pig iron from the unreliable method of judging it by fracture to the definite one of its actual elemental content.

2.—The introduction of machinery and processes to promote efficiency in operation and reduce shop costs; in specialty foundries, enormously so. The molding machine is the most prominent example of this advance.

3.—The study and rational use of foundry raw materials, such as molding sands, fuels, smaller supplies, etc.

4.—The machine-casting of pig iron.

5.—The standardization of methods of sampling and analysis of pig and cast iron. The preparation of standard drillings of cast iron for laboratory checking was first worked out by the foundry interests and is now a governmental activity.

6. — The classification of finished castings by their analysis ranges, so that the best composition can be selected as suited to the requirements of the case, and ready duplication is possible.

7.—The operation of gray iron and malleable foundries with scientific laboratory aid.

8. — The introduction of standard specifications for pig iron, cast iron and coke.

9.—The broadening of shop practice to include oil and gas fuels, improvement of product by steel and alloy additions, the electric furnace, etc.

10.—The study of the chemical and physical characteristics of cast iron, the results of which have taken it from the list of unreliable materials.

11. — Development along lines of foundry betterment, such as lighting, heating, sanitation, safety, efficiency and foundry education.

Two developments stand out preeminently in this array of achievement of the last 25 years and epitomize the two general directions of foundry evolution. These are the introduction of foundry metallurgy and of the molding machine. Opposition to both advances was most determined and hence, to live and spread, solid merit was essential. Of the thousands of foundrymen operating today the world-over, the progressives all mix their metal by analysis and use molding machines, and it will be but a question of time and inheritance by another generation until the others do likewise.

In any new development those who are on the firing line will usually work along their particular bent, and so we have one man studying cast iron from the standpoint of the mechanical engineer, another as a physicist, or as a metallurgist, and still others as production specialists. The moment the demand for a change or improvement was made plain, inventive genius stepped in and devised the necessary machinery to cope with the situation. The proceedings of the foundrymen's association, the technical press, governmental activity and inspection tours of foundrymen, all served to acquaint the foundry world with the progress made, and gradually the secrecy existing gave way to a wholesome interchange of experience with consequent increase of efficiency in individual plants, a better understanding between foundrymen, and the raising of the industry to a higher plane ethically and industrially.

The Early Struggle

In the early struggle for light much effort was wasted. Stars would appear on the horizon of foundry progress only to fall by the wayside. As usual, little knowledge proved a dangerous thing and attempts were constantly and disastrously made to cure the symptoms of defective practice instead of eradicating the disease. The writer often was called into consultation to overcome difficulties where the local specifications called for a given graphite content in pig iron, completely ignoring the silicon and sulphur, and again, woefully small test bars were relied upon in judging the daily run of work. From it all, however, came some good, for a knowledge of what not to do is just as essential as being able to hew to the line.

Coincident with the endeavor of definitely locating the underlying general principles of iron founding, there was developed the mechanical side of the foundry. The mechanical side of molding, with its acme in the jarring machine, can best be studied from the advertisements in the technical press. The inventors and every molding machine itself, deserve the hearty

commendation of foundrymen, for in spite of the defects and weaknesses of some of these machines, there is a place for all of them somewhere in the foundry and the discriminating foundryman profits by their introduction into his establishment.

As all methods of procedure, to be successful, must be based upon a sound foundation, the struggle to make a uniform and high grade line of castings depended primarily upon the purchase of pig iron by actual content and not by fracture. The principle of giving the customer exactly what he demanded and charging him for the additional chances and difficulties in production did not seem to obtain at the time, and hence the furnaces fought for a long time against what has since proved a blessing to their sales departments. Even to this time periodical attempts are made to formulate numbered grades with wide composition limits, when the real solution is to meet the foundryman's specification with agreed standard allowable variations dictated by safe furnace practice. Eventually, the furnace had to yield to the march of progress, and this in turn enabled the foundryman to work to closer requirements and consequently increased the reliability of his product.

International Specifications

The specification of pig iron by analysis has now advanced to the international stage, but England alone, of the great iron-producing countries, is not quite ready to agree inasmuch as the warrant system in use there requires modifications to meet the new condition. That time, however, will come also, and the foundry world will have moved one step ahead.

The question of selling by analysis undoubtedly has received material aid by the invention of the pig casting machine now found in most of the advanced furnace plants. Machine-cast iron can be judged by its fracture even less than sand cast pig iron and foundrymen must necessarily have the analysis of every shipment.

With the change of grading pig iron there was interjected the question of effective sampling and methods of analysis. This caused West to devise his system of standardized borings of cast iron for laboratory interchange, brought out under the auspices of the American Foundrymen's Association and since taken over by the United States bureau of standards. This association next instituted an investigation into standard methods of analysis of cast iron and coke, which question has also been happily solved. Long before this the problem of the standard test bar was taken up and settled effectually for America and is being considered for international agreement. It is hoped that this desirable end may soon be consummated.

Aids for the Foundryman

Tables giving standard compositions for the different lines of castings have been prepared by Porter, so that today the foundryman need no longer make expensive experiments when new lines of work come his way. Establishments of sufficient tonnage have their own laboratories to give first aid in foundry procedure, and the smaller foundries call upon the commercial laboratories as required. New furnace construction, other fuels, new methods of melting, etc., have no terrors for the well-informed foundryman, as he now knows the underlying principles of his art. The reduction of the total carbon in castings by the addition of steel scrap, with proper melting practice, has been extremely beneficial to cast iron since it has given the industry higher grade castings and has saved much work that would have been lost by other methods and to other materials.

One of the most important developments in foundry metallurgy has been the study of cupola melting carried out under the auspices of the United States bureau of mines, and today one need not have the slightest fear of bad results with that simplest and cheapest of melting devices—the cupola—if its principles are thoroughly understood. Even with the air furnace much of the uncertainty of results has been overcome with a knowledge of proper fuel combustion conditions and the necessity of keeping the furnace up to the pink of perfection continually, so that very short heats may be taken off, resulting in first-class iron.

Machinery has taken the place of hand labor from the very introduction of the raw material into the foundry. Grab buckets are used to unload and distribute sand and lifting magnets for handling pig iron and scrap. Mechanical charging machinery, of more or less doubtful metallurgical value, is now handling the materials going into the cupola, while conveying systems distribute sand, cores, molds and even take away castings just shaken-out, as well as refuse from the cupola dump, etc. Everywhere one witnesses the replacement of brawn by machine operation, effecting a large increase in output with a corresponding cost reduction and the saving of human effort and life itself.

The study of molding sands has opened up a great field for foundry improvement both in surface appearance of the castings and in the reduction of the floor discount. The establishment of a standard range of strength of bond in the molding sand heaps of foundries, and constant checking up to see that the lower limit is not reached, will do much toward keeping the output satisfactory. The information now available allows this to be done, and where introduced has saved much money otherwise lost in defective work made until the trouble has been located.

The introduction of the molding machine—from the old hand-squeezer to the modern types of jarring machines—has radically changed many operations. Mechanical sand tempering at night on the floor, or sand handling arrangements which collect the freshly shaken-out material in a lower story, add the necessary water and new sand, thoroughly mix and temper, reconvey to the floor above to the proper machine chutes to be used over again, are to be found in many shops at the present time. Perhaps the only weak point as yet in the application of power to aid the foundry operatives is in the handling of the mold after it is made on the machine. This is a back-breaking operation and it takes a robust man to carry away the hundreds of molds daily from the machine to the floor parking in the case of small molds in quantity casting. For the large classes of work modern crane facilities leave nothing to be desired.

Cost-Keeping

With the introduction of more exact methods of working there has naturally come the need of more exact cost-keeping. While the foundry world is still very much behind in this respect, the individual operator no longer evolves the cost of a casting out of his inner consciousness, but actually knows the items making it up, apart possibly, from the overhead. The day is coming when accurate costs will be more generally used in estimating selling prices.

Modern foundry advancement has relegated to the rear the rule-of-thumb man and a new class is in control of the industry. These men are not satisfied with former conditions and methods of operation and hence we see everywhere the introduction of betterment work. The molder sleeping off a night's debauch on the sand heap has not been witnessed in the foundry for many a day, nor does the bucket brigade parade between foundry and saloon during working hours any longer and sanitary installations enable the molder to feel like a man among men.

Pin Holes in Gray Iron Castings

By W. J. Keep

Question:—We are experiencing considerable difficulty in making a small casting, rectangular in shape, 1½ x 1¾ x 2¼ inches, which weighs 1½ pounds. It contains no cores and is practically solid throughout. The defects consist of pin holes or gas pockets on the cope side. In most instances a small pin hole appears on the surface, but underneath, this small hole enlarges to quite a cavity, the walls of which are smooth and of a bluish tint. The metal with which these castings were poured analyzes as follows: Silicon, 2.15 per cent; sulphur, 0.088 per cent; phosphorous, 0.608 per cent and managanese, 0.49 per cent. Originally the molds were made with a brass sand to insure a smooth surface on the castings, but believing that this was the cause of our trouble we tempered the sand to make it coarser and more open, but the defects still continue. We have poured these castings both with hot and cold metal, without success.

Answer: — The sulphur in this mixture is not sufficiently high to cause trouble and the pin holes evidently must be attributed to some other influence. It was ascertained that considerable rusty stove plate scrap was charged and it might be possible that some burned castings were in this scrap. This iron oxide generally passes off in the slag without injury to the castings. More thorough venting and gating should overcome the trouble.

Surface Gage Attachment for Pattern Shop Use

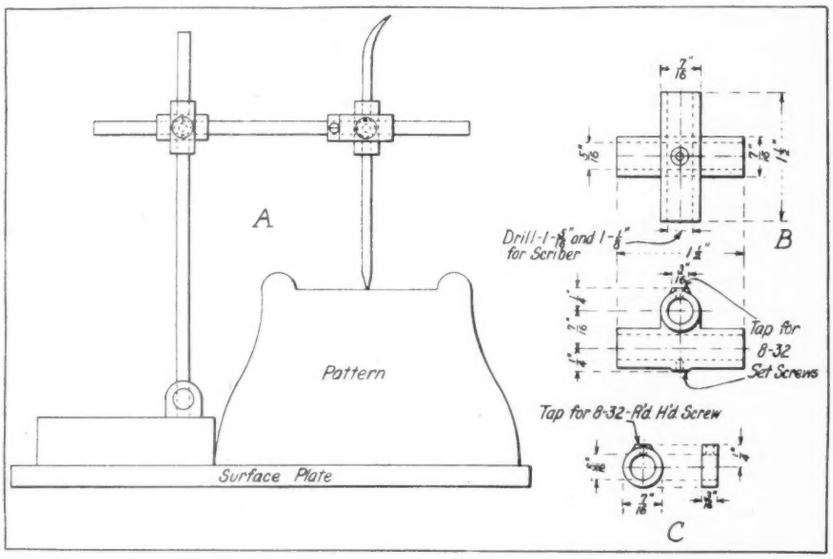
By S. L. Cook

The device shown in the accompanying illustration was designed to facilitate laying-out lines on patterns that are exceedingly hard to scribe by ordinary methods. While the instrument was intended primarily for patternmaking, there is no reason why it could not be used on any class of work where scribed lines are desired on awkward surfaces. The device was made for use with a surface gage having 5/16-inch diameter standard, but can easily be adapted to one having a ⅜-inch standard. As there are two standards of different lengths with most surface gages, the shorter one answers nicely for the cross bar of the device. The assembled instrument is shown at *A*, in the accompanying illustration. Both the pattern and the scribing device are placed on a surface plate.

Making the Device

To make the device, two small patterns are necessary as detailed at *B* and *C*. The castings may be made of brass, bronze or iron, two being required of *B* and one of the small collar, *C*. Provision is made for using the scriber of the gage so there will be no necessity for making or obtaining another.

By setting the collar in a required position and tightening the set-screw, the scriber may be revolved and lines projected on vertical surfaces. If set screws with knurled heads are provided, the gage may be set in position in a minimum time. As many surface plates have a line deeply scribed some distance from, and parallel to the edge, the work may be lined up easily. By using the pins provided in the surface gage, parallel lines and center lines may be laid out upon the surface of the pattern. Care should be taken in machining the parts of the device to be sure that the holes are at right angles to each other.



SURFACE GAGE ATTACHMENT FOR USE IN THE PATTERN SHOP

Will Install an Electric Furnace

The Haynes Stellite Co., Kokomo, Ind., has placed a contract with the Snyder Electric Furnace Co., Chicago, for the installation of an electric melting furnace with a capacity of 1½ tons in 24 hours.

Contraction of Malleable Castings

Question:—What is the cause of the wide variation in the shrinkage of malleable castings poured from the same heat? We have poured test bars ½ x 1 inch, cross-section and 12 inches long, from the same heat and have placed them in various pots in an annealing oven, and when annealed they varied considerably in size. As a rule, we have found that the greatest variation, either long or short, is in castings annealed in the lower or the upper parts of the annealing pots. Unfortunately, our results are not sufficiently reliable to enable us to prevent short castings occasionally. We have tried putting the short castings back and reannealing them, but this does not overcome the trouble.

Answer:—If the test bars made for the purpose of conducting this experiment were carefully molded so that they were absolutely of the same length in white iron, the annealed samples vary in length because of the lack of uniform temperature in all parts of the annealing oven. A metallographic examination of these bars would develop the fact also that their structure differs widely and due to this reason it is not at all surprising that they vary in length. Experiments made in annealing ovens where it was known that the bottoms of the pots and the corners of the ovens were of a different temperatures than at points on the top and near the fire pots, where bars to be dynamically tested were placed, developed what was anticipated, namely, that where the temperature was correct the results were satisfactory and where the temperature was not correct the results were just the reverse. If uniform contraction, and not shrinkage, is desired, it is essential that all castings be annealed under the same conditions.

Though new bauxite deposits are being found from time to time, there is considerable interest in the preparation of pure alumina from clay or other silicate minerals. As soon as a process for the extraction of alumina from clay is put on a commercial basis, large quantities of low-grade bauxite containing considerable admixtures of clay will become available as aluminum producers.

Making Car Wheels at Lenoir Car Works---IV

Annealing Practice of a Wheel Foundry With Side Lights on the Design and Construction of Pits—Shop Inspection

By G S Evans

THE preceding articles, published in the September, October and November numbers of THE FOUNDRY, described the mixture, melting and molding practice, respectively, at the Lenoir Car Works, Lenoir, Tenn. The next, and a most important operation in the manufacture of car wheels, is the annealing or heat-treatment which the wheels receive. It has been the custom, with the exception of a few foundries, since the beginning of the manufacture of chilled car wheels to dump the hot wheels into a soaking pit, throw some kind of a lid over it without much regard to temperature conditions, and allow them to cool off for several days in order to relieve shrinkage strains, after which they are removed and replaced by newly cast wheels. Annealing does more than relieve or equalize shrinkage strains. It effects structural changes in the iron-carbon alloys. However, it does not, as one writer has recently said, enlarge or coarsen the grain of the iron, as seen by the naked eye, but may enlarge the ferrite crystals in the gray portions by deposition of a part of the combined as temper-carbon. However, it does not materially soften the chilled tread of the wheels when annealed under the proper conditions of temperature. In order to meet the requirements of service, a chilled wheel must possess a hard, chilled tread and soft plates and hub. The hard tread is essential that it may become polished in service thereby reducing the friction between the tread and rail and minimizing the wear on each. The plates must be soft and flexible to withstand heavy loads and service shocks, and to resist temperature stresses, resulting from brake action. The soft hub is necessary to permit the wheel to be machined for axle fit. To produce a wheel according to the standard design of the Master Car Builders' Association with the present methods of molding and that will meet the foregoing requirements, necessitates the use of a high chilling iron that will produce a hard, dense chill on the tread. Such an iron is too hard and stiff for the thin sections of the plates as cast and requires subsequent annealing or tempering to soften the hub and plates, and to relieve strains set up during casting.

This usually is accomplished by conserving the latent heat of the wheel as cast, which is probably ample, if all could be conserved, to precipitate all of the combined carbon of both the gray and chilled parts of the wheel. Then the most important factor in the proper annealing of a wheel is to conserve this latent heat in the proportion that it is required to effect the proper tempering of the wheel.

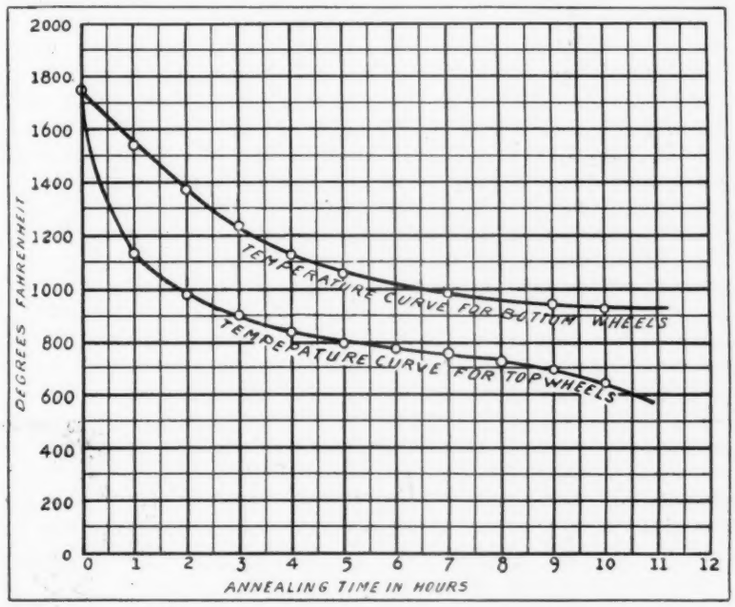


FIG. 1 — TEMPERATURE CURVES OF WHEEL ANNEALING PITS EQUIPPED WITH OLD STYLE CAST IRON COVER—CLOSED PIT ANNEALING

The present method of annealing, like the mixture and melting practice, was evolved as a result of exhaustive and expensive experiments. However, the results now obtained more than repay the cost several times annually.

At the time the experiments were begun, the company was losing a rather large percentage of wheels, as a result of shop losses and rejections on account of drop and thermal failures. Analyses were made of all wheels tested over a period of several months and the results tabulated in two columns, one showing the wheels that met the requirements of the specifications, and the other those that failed. A number of these are given in Table 1. It will be noted that the chemical analysis does not show great variations between the good and bad wheels, and that either may have identical chemical analyses. This did not seem to account for the differences, so that attention was directed to the physical analyses of the wheels, that is, the external color of the wheel was noted, the color and appearances of the fracture, the depth and appearance of the chill. These were tabulated in two columns, the good and the bad and comparisons made between both the chemical and physical analysis of each at the same time. By this it was noted that approximately 95 per cent of the thermal test failures were either blue or pale yellow in color and that the blue wheels also usually showed weaker under the drop test than the oxidized wheels. The only distinguishing characteristic that remained constant between the strong and weak wheels was the external color and this only for the thermal test, as some of the abnormal colored wheels showed exceptional strength (as compared to the average strength at that time) under the drop test.

At that time about 65 per cent of the wheels made were oxidized red, 20 per cent light or pale red, and 15 per cent blue. The blue wheels were being formed at the top of the annealing pits, the light or pale red wheels directly underneath the blue, and the oxide red wheels still lower down in the pits.

Experiments were made to determine the cause of the differences in the color

and strength of wheels from different parts of the annealing pits. An electric pyrometer was installed, which in addition to having the ordinary and recalescence thermo-couple, was equipped with an especially designed thermo-couple, 13 feet in length, with which it was possible to take temperature readings of the bottom wheels in the annealing pits.

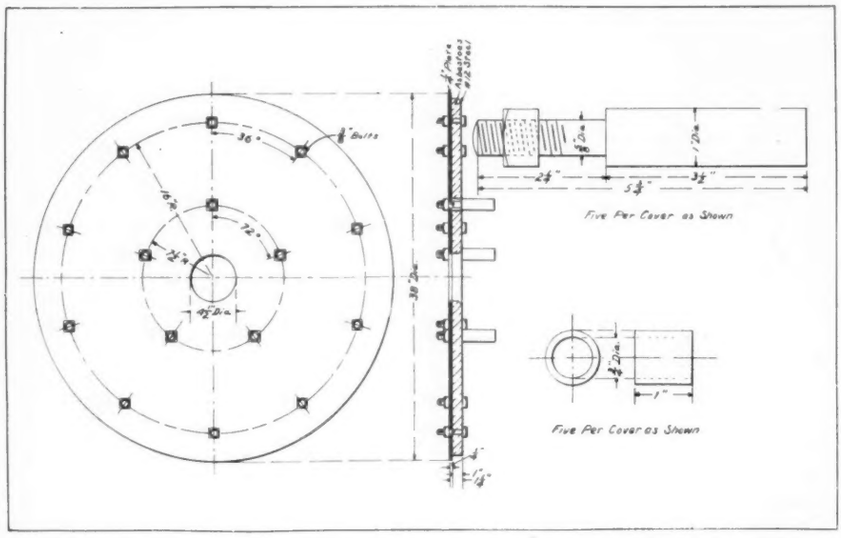


FIG. 2—ANNEALING PIT COVER DESIGNED FOR OPEN PIT ANNEALING

Temperature readings were taken of the top and bottom wheels in the pits, over a period of several days, and the results tabulated as shown in Fig. 1, in which the two curves represent the fall in temperature of the bottom and top wheels in the old style pits which were in use at that time. It will be noted from this that the initial fall in temperature is more rapid at the top of the pits, indicating that the wheels at this point were not receiving sufficient annealing.

A number of experiments were made to equalize the temperature between the tops and bottoms of the pits. As a result the cover illustrated in Fig. 2, was developed. This is made of two thin, steel plates with several layers of asbestos sheets arranged between the upper and lower plates, which are held together by bolts. It is made slightly less in diameter than the pits so that it can be lowered into the pits and is provided with five legs which rest upon the top wheels. In practice, the pits are filled only to within 3 feet of the top, the cover lowered until it rests upon the top wheels, after which the center hole is covered with a thin cast iron plate and any small opening around the outside edges of the cover are closed with small segmental plates each about 18 inches long, 3 inches wide and ⅜-inch thick, which are made to the radius of the lining of the pit. After 18 hours, the cover is removed to expedite cooling, and the wheels taken out at the end of 90 hours and more wheels put in immediately without allowing the pits to cool off any more than necessary. This method prevents the top wheel from cooling off too rapidly by radiation and at the same time allows some of the excess heat from the bottom of the pit to pass upward and maintain the temperature of the top wheels for a longer period of time.

Temperature readings taken on pits equipped with this style cover indicated that the initial drop in temperature of the top wheel was not nearly so rapid as with the old style cover.

This method of annealing practically eliminated the blue wheels and materially improved the strength of the upper wheels in the pits. However, these still continued to show weaker than the bottom wheels indicating that the annealing at the top of the pits was still insufficient to produce the strongest possible wheels.

The annealing pits illustrated in Fig. 3 were designed and built with a view of further improving the annealing of the top wheels as well as to prevent over-annealing of the wheels at the bottom of the pits. They are arranged in units of four with a 14-inch ventilator centrally spaced in each unit (as illustrated in the plan at the right) and extending to the bottom of the pits. Each has a capacity of 33 standard 33-inch wheels when filled to within 3 feet of the top, as shown in the sectional view, Fig. 3. The inside lining is made of a 4-inch fire brick which is backed with two layers of red brick taken from the old pits. The space between the pits is filled with loose brick bats and coarse sand which allows a certain amount of ventilation between the pits and the central ventilator.

Temperature readings were taken on these pits when using the open pit cover, as shown in position in section line *AA*, Fig. 3, and the results are tabulated in Fig. 4.

Comparing these to the curves shown in Fig. 1, it will be noted that the initial drop in temperature is not as rapid, but is more nearly uniform between the upper anl lower sections of the pit and that the mean temperature is higher for any given time.

In regular practice, the heavier wheels are put at the top of the pits and compare well in strength to wheels from the bottom; in addition, all wheels are uniform in color, namely a deep oxide red.

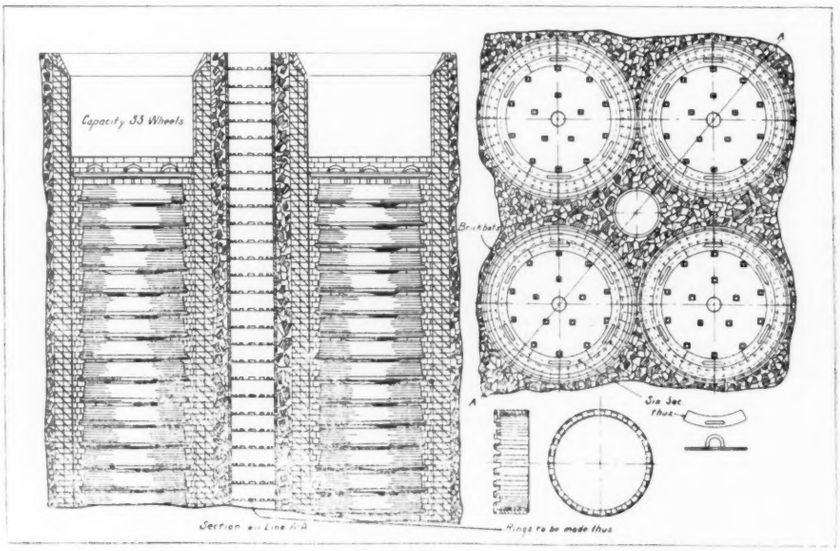


FIG. 3—ANNEALING PITS OF IMPROVED DESIGN

The old style annealing pit with its heavy cast iron cover is illustrated in Fig. 5. These had a capacity of 20 wheels when filled to within about a

TABLE CONVERTING MILLIMETERS TO INCHES.

By Thomas A. Rance

Based on 1 millimeter = 0.03937 inch.

Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.
501	19.72437	551	21.69287	601	23.66137	651	25.62987	701	27.59837
502	19.76374	552	21.73224	602	23.70074	652	25.66924	702	27.63774
503	19.80311	553	21.77161	603	23.74011	653	25.70861	703	27.67711
504	19.84248	554	21.81098	604	23.77948	654	25.74798	704	27.71648
505	19.88185	555	21.85035	605	23.81885	655	25.78735	705	27.75585
506	19.92122	556	21.88972	606	23.85822	656	25.82672	706	27.79522
507	19.96059	557	21.92909	607	23.89759	657	25.86609	707	27.83459
508	19.99996	558	21.96846	608	23.93696	658	25.90546	708	27.87396
509	20.03933	559	22.00783	609	23.97633	659	25.94483	709	27.91333
510	20.07870	560	22.04720	610	24.01570	660	25.98420	710	27.95270
511	20.11807	561	22.08657	611	24.05507	661	26.02357	711	27.99207
512	20.15744	562	22.12594	612	24.09444	662	26.06294	712	28.03144
513	20.19681	563	22.16531	613	24.13381	663	26.10231	713	28.07081
514	20.23618	564	22.20468	614	24.17318	664	26.14168	714	28.11018
515	20.27555	565	22.24405	615	24.21255	665	26.18105	715	28.14955
516	20.31492	566	22.28342	616	24.25192	666	26.22042	716	28.18892
517	20.35429	567	22.32279	617	24.29129	667	26.25979	717	28.22829
518	20.39366	568	22.36216	618	24.33066	668	26.29916	718	28.26766
519	20.43303	569	22.40153	619	24.37003	669	26.33853	719	28.30703
520	20.47240	570	22.44090	620	24.40940	670	26.37790	720	28.34640
521	20.51177	571	22.48027	621	24.44877	671	26.41727	721	28.38577
522	20.55114	572	22.51964	622	24.48814	672	26.45664	722	28.42514
523	20.59051	573	22.55901	623	24.52751	673	26.49601	723	28.46451
524	20.62988	574	22.59838	624	24.56688	674	26.53538	724	28.50388
525	20.66925	575	22.63775	625	24.60625	675	26.57475	725	28.54325
526	20.70862	576	22.67712	626	24.64562	676	26.61412	726	28.58262
527	20.74799	577	22.71649	627	24.68499	677	26.65349	727	28.62199
528	20.78736	578	22.75586	628	24.72436	678	26.69286	728	28.66136
529	20.82673	579	22.79523	629	24.76373	679	26.73223	729	28.70073
530	20.86610	580	22.83460	630	24.80310	680	26.77160	730	28.74010
531	20.90547	581	22.87397	631	24.84247	681	26.81097	731	28.77947
532	20.94484	582	22.91334	632	24.88184	682	26.85034	732	28.81884
533	20.98421	583	22.95271	633	24.92121	683	26.88971	733	28.85821
534	21.02358	584	22.99208	634	24.96058	684	26.92908	734	28.89758
535	21.06295	585	23.03145	635	24.99995	685	26.96845	735	28.93695
536	21.10232	586	23.07082	636	25.03932	686	27.00782	736	28.97632
537	21.14169	587	23.11019	637	25.07869	687	27.04719	737	29.01569
538	21.18106	588	23.14956	638	25.11806	688	27.08656	738	29.05506
539	21.22043	589	23.18893	639	25.15743	689	27.12593	739	29.09443
540	21.25980	590	23.22830	640	25.19680	690	27.16530	740	29.13380
541	21.29917	591	23.26767	641	25.23617	691	27.20467	741	29.17317
542	21.33854	592	23.30704	642	25.27554	692	27.24404	742	29.21254
543	21.37791	593	23.34641	643	25.31491	693	27.28341	743	29.25191
544	21.41728	594	23.38578	644	25.35428	694	27.32278	744	29.29128
545	21.45665	595	23.42515	645	25.39365	695	27.36215	745	29.33068
546	21.49602	596	23.46452	646	25.43302	696	27.40152	746	29.37002
547	21.53539	597	23.50389	647	25.47239	697	27.44089	747	29.40939
548	21.57476	598	23.54326	648	25.51176	698	27.48026	748	29.44876
549	21.61413	599	23.58263	649	25.55113	699	27.51963	749	29.48813
550	21.65350	600	23.62200	650	25.59050	700	27.55900	750	29.52750

(*Continued on Data Sheet No. 202.*)

TABLE CONVERTING MILLIMETERS TO INCHES.

By Thomas A. Rance

(*Continued from Data Sheet No. 201.*)

Based on 1 millimeter = 0.03937 inch.

Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.	Millimeters.	Inches.
751	29.56687	801	31.53537	851	33.50387	901	35.47237	951	37.44087
752	29.60624	802	31.57474	852	33.54324	902	35.51174	952	37.48024
753	29.64561	803	31.61411	853	33.58261	903	35.55111	953	37.51961
754	29.68498	804	31.65348	854	33.62198	904	35.59048	954	37.55898
755	29.72435	805	31.69285	855	33.66135	905	35.62985	955	37.59835
756	29.76372	806	31.73222	856	33.70072	906	35.66922	956	37.63772
757	29.80309	807	31.77159	857	33.74009	907	35.70859	957	37.67709
758	29.84246	808	31.81096	858	33.77946	908	35.74796	958	37.71646
759	29.88183	809	31.85033	859	33.81883	909	35.78733	959	37.75583
760	29.92120	810	31.88970	860	33.85820	910	35.82670	960	37.79520
761	29.96057	811	31.92907	861	33.89757	911	35.86607	961	37.83457
762	29.99994	812	31.96844	862	33.93694	912	35.90544	962	37.87394
763	30.03931	813	32.00781	863	33.97631	913	35.94481	963	37.91331
764	30.07868	814	32.04718	864	34.01568	914	35.98418	964	37.95268
765	30.11805	815	32.08655	865	34.05505	915	36.02355	965	37.99205
766	30.15742	816	32.12592	866	34.09442	916	36.06292	966	38.03142
767	30.19679	817	32.16529	867	34.13379	917	36.10229	967	38.07079
768	30.23616	818	32.20466	868	34.17316	918	36.14166	968	38.11016
769	30.27553	819	32.24403	869	34.21253	919	36.18103	969	38.14953
770	30.31490	820	32.28340	870	34.25190	920	36.22040	970	38.18890
771	30.35427	821	32.32277	871	34.29127	921	36.25977	971	38.22827
772	30.39364	822	32.36214	872	34.33064	922	36.29914	972	38.26764
773	30.43301	823	32.40151	873	34.37001	923	36.33851	973	38.30701
774	30.47238	824	32.44088	874	34.40938	924	36.37788	974	38.34638
775	30.51175	825	32.48025	875	34.44875	925	36.41725	975	38.38575
776	30.55112	826	32.51962	876	34.48812	926	36.45662	976	38.42512
777	30.59049	827	32.55899	877	34.52749	927	36.49599	977	38.46449
778	30.62986	828	32.59836	878	34.56686	928	36.53536	978	38.50386
779	30.66923	829	32.63773	879	34.60623	929	36.57473	979	38.54323
780	30.70860	830	32.67710	880	34.64560	930	36.61410	980	38.58260
781	30.74797	831	32.71647	881	34.68497	931	36.65347	981	38.62197
782	30.78734	832	32.75584	882	34.72434	932	36.69284	982	38.66134
783	30.82671	833	32.79521	883	34.76371	933	36.73221	983	38.70071
784	30.86608	834	32.83458	884	34.80308	934	36.77158	984	38.74008
785	30.90545	835	32.87395	885	34.84245	935	36.81095	985	38.77945
786	30.94482	836	32.91332	886	34.88182	936	36.85032	986	38.81882
787	30.98419	837	32.95269	887	34.92119	937	36.88969	987	38.85819
788	31.02356	838	32.99206	888	34.96056	938	36.92906	988	38.89756
789	31.06293	839	33.03143	889	34.99993	939	36.96843	989	38.93693
790	31.10230	840	33.07080	890	35.03930	940	37.00780	990	38.97630
791	31.14167	841	33.11017	891	35.07867	941	37.04717	991	39.01567
792	31.18104	842	33.14954	892	35.11804	942	37.08654	992	39.05504
793	31.22041	843	33.18891	893	35.15741	943	37.12591	993	39.09441
794	31.25978	844	33.22828	894	35.19678	944	37.16528	994	39.13378
795	31.29915	845	33.26765	895	35.23615	945	37.20465	995	39.17315
796	31.33852	846	33.30702	896	35.27552	946	37.24402	996	39.21252
797	31.37789	847	33.34639	897	35.31489	947	37.28339	997	39.25189
798	31.41726	848	33.38576	898	35.35426	948	37.32276	998	39.29126
799	31.45663	849	33.42513	899	35.39363	949	37.36213	999	39.33063
800	31.49600	850	33.46450	900	35.43300	950	37.40150	1,000	39.37000

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

THE FOUNDRY DATA SHEET, JANUARY, 1916

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

foot of the top, as was the practice before the experiments were begun. As will be noted, these were built close together and the spaces between each filled with solid masonry. This prevented any ventilation for the excess heat at the bottom of the pit and often resulted in these wheels being over-annealed, while the heavy cast iron ring and cover at the top absorbed the heat from the upper wheels, thereby preventing the proper amount of annealing.

With the new design, illustrated in Fig. 3, a part of the excess heat at the bottom passes up through the wheels to maintain a uniform temperature throughout the length of the pit. The ventilator shown in the center of each four pits is built up of cast iron rings, 14 inches in diameter and 7 inches high, each having one edge scalloped, as illustrated in Fig. 3, to provide ventilation between the ventilator and pits. This allows part of the heat to pass off from the bottom and prevents over-annealing at this point.

As previously stated, the improved method of annealing, produces an oxide red wheel throughout the entire length of the annealing pit. This results from relatively slow oxidation of the external surface of the wheel during the annealing process, and the amount of oxidation (depth of color) is an indication of the amount of annealing that each wheel receives.

This method of annealing also has other advantages. It reduces the number of pits required for any given capacity per day and thereby curtails the floor space required for the annealing; by cutting the annealing period, the pits may be used more frequently. The greater mass of uniformly hot wheels in each pit will tend to correct any individual wheels that may not have been pitted at the proper temperature. The core binder of the ring cores is completely oxidized (burned) so that it will sift out through the vent holes as the wheel is being rolled about in cleaning, without requiring special labor for this operation. Correct and uniform annealing is absolutely essential to the production of strong wheels, and this method, so far as our experiments have gone, produces a more nearly uniformly annealed wheel throughout the length of the pit from top to bottom, without any over-annealing of the bottom wheels. The microphotographs shown in Figs. 6, 7, 8, 9, 10 and 11 illustrate the effect of annealing on the structure of 1¼-inch round gray and ¼-inch round chilled test bars at the top and bottom of the pits, as compared to unannealed specimens of the same bars. The two test bars, one chilled and one gray, were cast from the regular wheel mixture in a dry sand and chill mold, respectively. After cooling sufficiently to be handled with the naked hand, they were broken into three pieces each. One piece of each was placed on the plate of the second wheel from the top of the annealing pit and one of each on the plate of the bottom wheel. They were taken out with the wheels in regular order and microphotographs made of these and the untreated specimens.

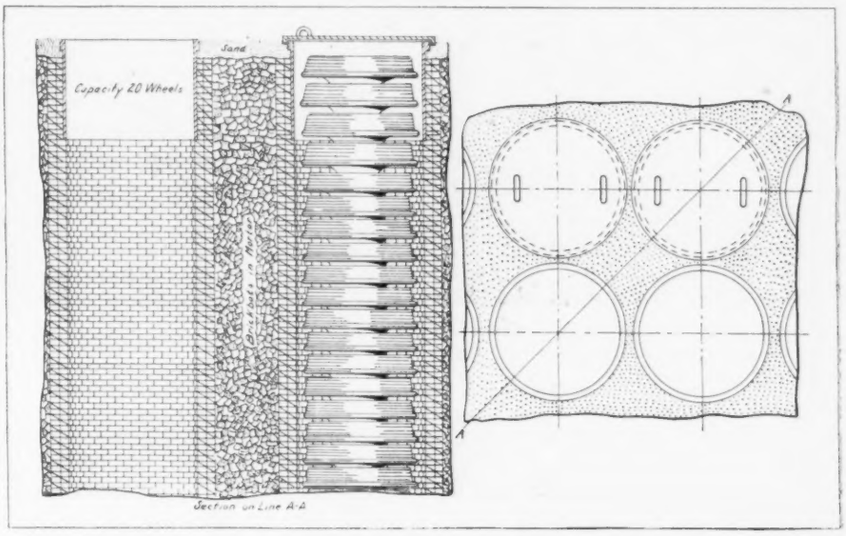


FIG. 5—OLD STYLE ANNEALING PIT FORMERLY IN USE

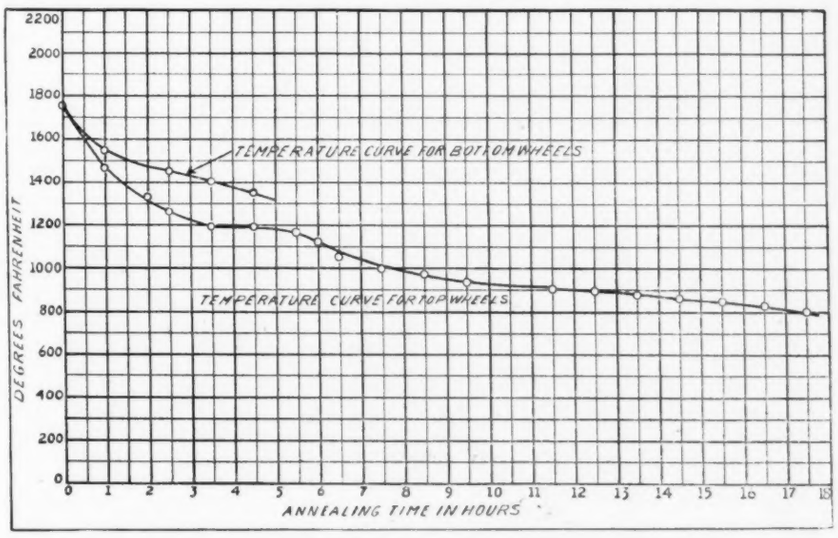


FIG. 4—TEMPERATURE CURVES OF IMPROVED DESIGN PITS EQUIPPED WITH NEW COVER FOR OPEN PIT ANNEALING

Comparing the microphotographs of the gray iron specimens, Fig. 6, 7 and 8, it will be noted that the hypo-eutectoid structure of Fig. 6 is changed to the hyper-eutectoid structure of Fig. 7 and that practically all of the pearlite of Fig. 8 is changed to ferrite and graphite.

Comparing the microphotographs of the chilled specimens, Figs. 9, 10 and 11, it will be noted that the structure is not apparently changed materially by the annealing. This same condition prevails in the wheels, that is, the annealing appears to effect greater structural changes in the soft plates than it does in the chilled tread.

These illustrate the relative amount of annealing at different parts of the pit, and its effect on the structure of small test bars only, as the structure of the gray portion of the wheel is not so completely changed during the annealing process as that of the test bars shown in the microphotographs. This is probably due, in part, to the differences in the cross-section of the two.

It will be noted that the annealing is slightly greater at the bottom of the pits. However, the variation between the temperature conditions of the top and bottom is much less with the improved method of annealing than with the old style pit formerly in use, or

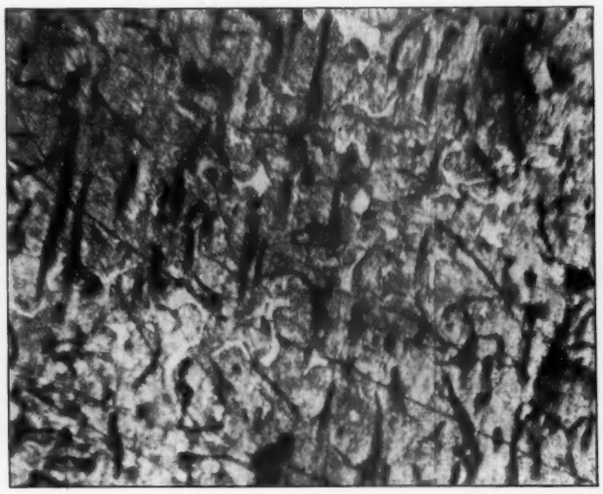


FIG. 6—MICROPHOTOGRAPH OF UNANNEALED, 1¼-INCH, GRAY IRON TEST BAR

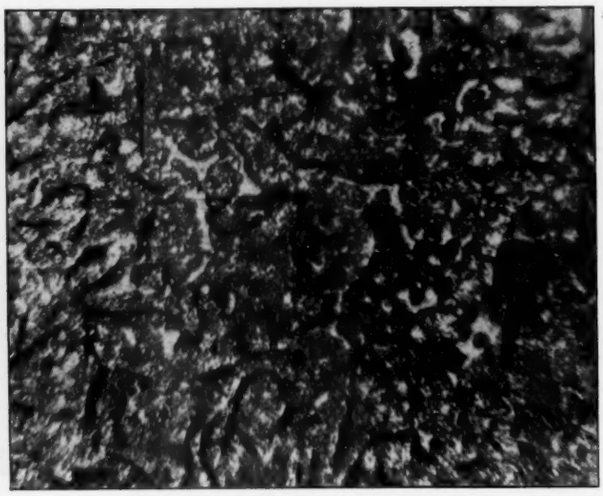


FIG. 7—MICROPHOTOGRAPH OF GRAY IRON TEST BAR ANNEALED AT TOP OF PIT

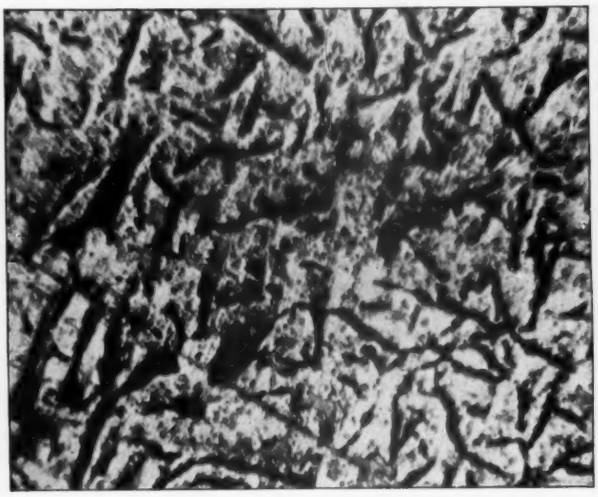


FIG. 8—MICROPHOTOGRAPH OF GRAY IRON TEST BAR ANNEALED AT BOTTOM OF PIT

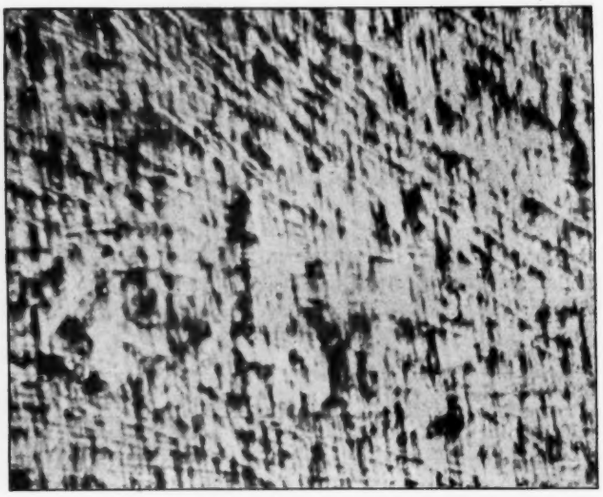


FIG. 9—MICROPHOTOGRAPH OF UNANNEALED SPECIMEN, ¾-INCH CHILLED BAR

FIG. 10—MICROPHOTOGRAPH OF CHILLED BAR ANNEALED AT TOP OF PIT

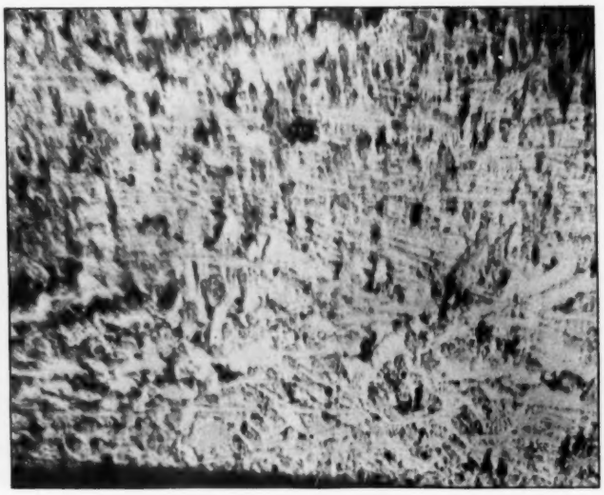


FIG. 11—MICROPHOTOGRAPH OF CHILLED BAR ANNEALED AT BOTTOM OF PIT

with any other design of wheel-annealing pit with which the writer is familiar.

In regular practice, all top wheels in the pits are listed as such on the wheel record and are kept separate. Before offering the day's cast to the railroad inspector, the records of all wheels (as described in the November number of *The Foundry*) are carefully examined by the shop foreman; any that appear weak for any cause are rejected and sent to the scrap dock. By keeping complete and detailed records of each wheel from its beginning in the cupola charge, through the different stages of melting, molding and annealing, and by using these records in making shop inspection before the wheel is ready to go to the consumer, we are able to guarantee a comparatively uniform wheel, which, as shown by the daily tests, possesses several times the required strength as specified by the American Society for Testing Materials in its standard specification for 33-inch chilled car wheels.

Table I.

Analyses of wheels that passed the M. C. B. A. test as compared with those that failed.

WHEELS THAT PASSED THE TEST

Silicon, per cent.	Sulphur, per cent.	Manganese, per cent.	Phosphorus, per cent.	Combined Carbon, per cent.	Graphitic Carbon, per cent.	Total Carbon, per cent
0.70	0.159	0.46	0.41	1.04	2.07	3.11
0.66	0.131	0.55	0.42	0.69	2.75	3.44
0.62	0.137	0.52	0.40	0.78	2.61	3.39
0.68	0.144	0.57	0.42	0.89	2.59	3.48
0.71	0.144	0.56	0.40	0.76	....	....
0.64	0.129	0.58	0.42	0.58	2.68	3.26

WHEELS THAT DID NOT MEET SPECIFICATIONS

Silicon, per cent.	Sulphur, per cent.	Manganese, per cent.	Phosphorus, per cent.	Combined Carbon, per cent.	Graphitic Carbon, per cent.	Total Carbon, per cent
0.56	0.123	0.58	0.43	0.64	2.77	3.41
0.57	0.123	0.52	0.43	0.72	....	....
0.60	0.133	0.55	0.42	0.88	2.40	3.28
0.65	0.142	0.58	0.41	0.67	2.73	3.40
0.63	0.134	0.51	0.42	0.74	2.67	3.41
0.71	0.154	0.53	0.42	1.06	2.24	3.30

A study of Table I should prove of interest to those engaged in car wheel practice. The analyses of the wheels which passed the Master Car Builders' Association test and those that did not meet with the required specifications are given. A comparison of the percentages of the different elements contained in the good and the bad wheels does not indicate sufficient variation to enable one to attribute failure to chemical content. The phosphorus percentage of the good and bad wheels is almost identical and there is no great variation in the silicon and the sulphur.

Reclamation of Magnalium From Turnings

By John Coulson

THE use of magnalium metal for finished castings has increased to such an extent, that the recovery of the metal from the turnings has become an important factor. In this article a method of acquiring a very reliable metal from turnings, without suffering more than 1 or 2 per cent loss in the melting is presented.

It is well known, of course, that magnalium metal is an alloy of aluminum and magnesium, having a specific gravity less than that of pure aluminum. Magnalium containing from 5 to 10 per cent of magnesium has very desirable phyiscal characteristics, and castings made from it can be machined without difficulty. The extensive use of this metal by the Westinghouse company in the manufacture of automobile parts and electrical apparatus brought about the problem of recovering the metal from the great quantity of turnings accumulated in finishing the castings. Ordinary methods of melting down scrap metal could not be applied in the case of magnalium, on account of the rapidity with which the turnings oxidized. Therefore, a systematic study of the problem was taken up, and the results of this work, which was completed December, 1914, are perhaps of sufficient interest to warrant citation.

Oxidation of finely divided magnalium progresses more rapidly and violently than in the case of aluminum, and it is well known that freshly cut aluminum is covered with an oxide film immediately on exposure to the air. The temperature of a twisted mass of bare aluminum wire can be raised above the melting point without becoming diffused; the wire may sag, but when cooled will be found intact. The jacket of Al_2O_3 prevents the wire from melting into a solid molten mass, and becomes even stronger under comparatively high temperatures. Therefore, some process of agitating the melted material must be applied, in order to break up the oxide films, thus forcing the molten material to diffuse. Fluxes composed of chlorides and fluorides of the alkaline earths have been used with some success. Such fluxes, when hot, dissolve a certain amount of the oxide, and their gassing throws about the globules of molten metal, inviting them to coalesce. The use of cryolite in the reduction of aluminum has long been known and is quite commonly used for smothering aluminum chips. The cryolite is first melted into a viscous state, then the scrap aluminum is fed into the crucible and pushed under the surface of the flux; the protective layer of cryolite on top prevents the chips from further oxidation. The Westinghouse foundry has used this method for some time in melting magnalium turnings and the recovery for clean material varied from 60 to 90 per cent. Usually, equal weights of cryolite and turnings were added to the melting pot.

The use of cryolite as a flux is objectionable, however, since it attacks silicon or graphite crucibles vigorously, and iron pots cannot be used when pure metal is required. The desirability to avoid using it as a flux led to extensive experiments to find if it was possible to melt the turnings, without appreciable loss, in the presence of some inert or reducing gas. As the work progressed, small, special, air-tight, cylindrical shells were built, as the method of applying the gas demanded. The cavity inside the shell admitted a Gooch crucible which held the charges of turnings to be melted. Tight-fitting caps, pierced with gas pipes, closed the ends of the cylinder. The whole fitted inside an electric furnace, which had a limiting temperature of 1,200 degrees Cent. With everything in place, and after the gas had been washing out the system for five to ten minutes, the elec-

A paper presented at the Atlantic City convention of the American Institute of Metals, Sept. 28-Oct. 1, 1915.

tric current was turned on and the temperature raised to 900 degrees Cent. Of the numerous gases used throughout the work, hydrogen gave the best results. Tests were made to see if forcing the gas through the charge as in the bessemer process, would break up and diffuse the molten globules, but the results were inferior to those in the case where the gas was admitted through the pipe overhead. With downward flow, the loss was about 10 per cent. The loss always appeared in the form of fine white powder, and on examination of this residue it was found that nitrides were formed. A strong odor of ammonia was given off when the residue came in contact with water. The vigorous evolution of this gas indicated that nitrogen was occluded in some way, and most likely in the pores of the turnings, since great care had been taken to free the hydrogen used of all contamination.

The next step was to free the turnings of all foreign matter and occluded air, replacing it by some inoffensive fluxing agent; common salt, NaCl, served this purpose very well. The turnings were boiled for a few minutes in a 4 per cent salt solution, which was then poured off, taking with it the objectionable scum which would otherwise adhere to the turnings if they were scooped out. Further experiments were made, using the apparatus described above, and charges of the turnings, still moist with the salt solution, but the results were not as good as we had expected. In every case a small amount of turnings remained intact and on top of the metal which had united. A new apparatus was constructed in which gas pressure from above forced the melted turnings through holes in the bottom of the crucible and into a receptacle underneath. In this way it was possible to recover about 92 per cent of the charge, but to use this method on a large scale appears difficult.

It was thought possible to melt the turnings in an open crucible after they had been boiled in a solution of slightly fluxing salt; experiment proved this method to be a success. The turnings, after being washed thoroughly in benzine, were boiled in a salt solution which was poured off just before charging the metal into the crucible. The crucible fitted snugly through a hole in the cover of an ordinary blast furnace which was heated to a temperature of 900 degrees Cent. before starting. The damp turnings were then fed into the hot crucible and by mechanical means forced to coalesce as they melted. Each addition of turnings was thoroughly puddled until the mass again became uniformly viscous. Melts from one to six pounds were handled in this manner, using different salts and combinations of salts for the bath. A 4 per cent solution of NaCl gave very good results; the recovery being 96.2 per cent.

The application of this puddling process in melting the turnings in the open crucible without preliminary treatment in the salt solution also proved satisfactory. To start the melt, a small pellet of magnalium was reduced to a molten state in the bottom of the crucible; this permitted puddling to proceed on the first application of the turnings, thus smothering them immediately. The average loss from a number of melts of about six pounds each was 6 per cent.

It was found desirable to let the charge stand in the hot crucible for 10 or 15 minutes after the last puddling operation. This gave the oxide time to rise to the surface, where it was held while the clean metal was poured from underneath. The dross-like mass that remained in the crucible, after pouring, contained some good metal, but this was separated from the oxide by adding a small quantity of $CaCl_2$ and stirring the whole vigorously. If the metal began to burn, as will be the case if the temperature gets much above 800 degrees Cent., a little cryolite, powdered, was added. It effectually stopped the action. Drawing the charge off through a hole in the bottom of the crucible, in place of pouring from the top, alleviated the danger of the charge burning up and permitted the work to go on without having to displace the crucible. The metal recovered from the turnings can hardly be expected to be as good as the original magnalium. It is practically impossible to avoid the entanglement of some oxide in the melting. However, the physical characteristics of the reclaimed metal can be much improved, if not restored completely by the introduction of a deoxidizing agent. Test pieces were poured from melts of new and reclaimed metal, which experienced different treatment, or had added to them a small quantity of deoxidizing metal. The results, which are tabulated herewith, show what may be expected from the various combinations and treatment of the metal. As will be noted, the magnalium made in the laboratory, indicated by the first set of results, is much superior to the shop metal from which the turnings come. Therefore, the characteristics of the reclaimed metal from the turnings are not likely to excel those of the original magnalium.

From the foregoing discussion it is evident that a simple process has been developed for melting down magnalium turnings without heavy loss, or the aid of cryolite and also that means of improving the quality of

PHYSICAL TESTS OF NEW AND RECLAIMED MAGNALIUM.

History of pieces.	Tensile strength, pounds per square inch.	Yield point, pounds per square inch.	Elastic limit, pounds per square inch.	Elongation in 2 inches, per cent.	Reduction, per cent.
New Material					
Laboratory 95 per cent aluminum, 5 per cent manganese	24,500	11,000	6,000	9.2	13.4
Laboratory 95 per cent aluminum, 5 per cent manganese	23,100	11,000	5,000	8.7	11.5
Shop 95 per cent aluminum, 5 per cent manganese	21,700	19,800	11,200	1.8	1.6
Shop 95 per cent aluminum, 5 per cent manganese	24,550	16,250	11,500	4.0	3.9
Shop 95 per cent aluminum, 5 per cent manganese	19,630	17,000	9,700	2.3	1.6
Laboratory aluminum	13,150	7,500	4,000	33.0	52.0
Reclaimed Turnings, Fluxed or Washed With Hydrogen on Second Melting					
Laboratory No. flux	12,100	11,000	600	0.0	0.0
Laboratory No. flux	13,750	13,750	10,000	0.0	0.0
Laboratory hydrogen wash	13,870	13,800	7,200	0.0	0.0
Laboratory under cryolite	20,100	17,500	10,750	0.0	0.0
Laboratory under cryolite	11,950	11,950	9,500	0.0	0.0
Laboratory No flux, 45 minutes wait	19,300	15,250	800	1.5	3.5
Shop. Under cryolite	15,000	13,000	12,500	0.0	0.0
Shop. Under cryolite	14,500	12,500	12,500	0.0	0.0
Shop. Under cryolite	21,750	21,750	16,500	0.0	0.0
Shop. Under cryolite	19,500	19,500	14,500	0.0	0.0
Shop. Under cryolite	13,750	13,750	10,000	0.0	0.0
Shop. Under cryolite	13,900	13,500	7,200	0.0	0.0
Reclaimed Turnings Deoxidized on Second Melting					
Laboratory ½ per cent aluminum manganese	23,000	20,250	12,500	1.3	3.9
Laboratory 1½ per cent Met. Cal.	24,750	16,000	9,500	2.0	3.9
Laboratory 1 per cent Met. Cal.	24,370	18,000	8,500	2.0	5.9
Laboratory ½ per cent calcium aluminum silicide	24,430	19,000	8,500	3.7	7.8

the metal have been devised. In melting the turnings, the most satisfactory results were obtained by first heating the crucible or furnace to a temperature of 900 degrees Cent., then melting down in it a pellet of solid metal, preparatory to feeding in the loose turnings. This supplied molten metal to engulf the turnings at the outset and permitted the puddling operation to go on at once. This method of procedure has been applied with success, the loss from a 200-pound charge being about 1 per cent. The recovered metal is poured in the form of large pellets and later treated before making it into castings. From examination of the tables of physical tests it will be seen that the introduction of a deoxidizing agent brings the physical characteristics of the old metal up to that of the original shop material. The addition of 1 per cent of metallic calcium, or 0.5 per cent of calcium aluminum silicide is quite sufficient to restore the reclaimed metal to its original physical state.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Making Bronze to Specifications

We are experiencing some difficulties with our bronze mixture, which must comply with the following specifications: Copper, 79.7 per cent; tin, 10 per cent; lead, 9.5 per cent, and phosphorus, 0.8 per cent. The amount of tin shall not be less than 9 per cent nor more than 11 per cent. The amount of lead shall not be less than 8 per cent nor more than 11 per cent. The amount of phosphorus shall not be less than 0.7 per cent nor more than 1 per cent. The amount of ingredients other than copper, tin, lead and phosphorus shall not exceed 0.5 per cent. In making this mixture we have used 74.5 per cent of ingot copper which is melted in a crucible in a pit furnace. When it has attained the proper temperature the copper is drawn from the furnace and 6.5 per cent of 15 per cent phosphor-copper is added, as well as 10 per cent of tin and 9 per cent of lead. This is stirred thoroughly with a graphite stirring rod. According to our way of figuring, the mixture should analyze within the limits of the foregoing specifications, but there evidently is some fault in our method of procedure, as up to the present time we are unable to keep our four ingredients within bounds. In several instances we have had a correct analysis with the exception of the phosphorus, which has fallen to 0.6 per cent instead of 0.7 per cent, which is the minimum.

Allowance always must be made for the oxidizable elements when making alloys which are specified to be within certain limits. The alloy aimed at in this instance is the well known 80, 10 and 10 and the lead added to the mixture could be increased to 10 per cent to effect economies if desirable. The loss of phosphorus, however, appears to be excessive and this may be due to the phosphor-copper, which perhaps does not contain 15 per cent of phosphorus, or to faulty methods of determining the percentage of phosphorus in the mixture. In any event, it would be advisable to allow for more phosphorus by increasing the phosphor copper to 7.5 per cent, thus adding theoretically 1.12 per cent phosphorus, which would allow for a loss of this element of 0.37 per cent. This would still be within the limits specified.

Pit Furnace Details

Will you kindly give us information regarding pit furnaces for brass foundry use? What should be the size of stack necessary to take care of 10 No. 60 pots and how deep should the furnace be placed? What should be the distance between the top of the crucible and the entrance to the flue?

A stack 24 inches in diameter and 60 feet in height will insure plenty of draft for 10 furnaces taking No. 60 pots. The furnaces can be placed level with the floor or may be about 10 inches above the ground. This is a matter of individual preference. The crucible, when freshly coaled, should be 3 or 4 inches below the bottom of the flue. A furnace 30 inches in depth and 17 inches in diameter is sufficiently large for a No. 60 crucible, allowing for 6 inches of fuel beneath the pot. The size of the furnace flues should be 5 x 7 inches and the main flue should be about equal to the area of the stack.

Acid-Resisting Metal

Kindly give me a formula for an acid-resisting metal that will give good service.

Retz alloy is considered a good metal for acid work. The mixture follows: Copper, 74.3 per cent; tin, 11.4 per cent; lead, 8.9 per cent, and antimony, 5.4 per cent.

Mixtures for Water Jacket Cores

We would like to have good mixture for water jacket cores, for both iron and brass using linseed oil as a binder, and a mixture for cylinder cores, using flour and rosin as a binder.

For water jacket cores use one part linseed oil to 32 parts of sand. Another good oil sand mixture follows: Dry new molding sand, 50 pounds; silica or other sharp sand, 70 pounds and linseed oil, 3 pounds, 2 ounces.

For a rosin core use one pound of powdered rosin to 25 pounds of dry sand for a strong core. Flour is used in the proportion of from one part of flour to 8, 10 or 12 parts of sand, according to the amount of handling to which the core is subjected. The proportion of binder to sand in making cores can be decreased materially by thoroughly mixing the sand in the binder.

Melting Manganese Copper

We would like to know how to mix and melt manganese copper.

For some purposes 80 per cent ferro-manganese is mixed with copper to make manganese copper. Ferro-manganese is used for making manganese copper if the iron in the mixture is not objectionable. In making manganese bronze the alloy of manganese copper containing iron generally is used and is satisfactory for the reason that iron usually is one of the constituents in manganese bronze. If the manganese copper, however, is to be used for making alloys in which the manganese content is high and is added for the specific purpose of making the alloy white in color, or to produce a resistance alloy, or one that will withstand a considerable temperature and which also must be machinable, then it is important that the manganese copper be free from

iron, otherwise the iron will segregate in nodules and will ruin the alloy.

In this case, the manganese copper will be produced at an increased expense over that containing ferro-manganese and should be made by melting together the required percentages of manganese metal and copper, an exceedingly high temperature being required to effect a proper mixture. If the iron alloy is satisfactory, granulated ferro-manganese is employed, which is added to the molten copper. If 80 pounds of copper are melted under charcoal, to which 20 pounds of 80 per cent ferro-manganese are added gradually, an alloy will be formed containing about 16 per cent manganese and 1.6 to 2 per cent iron. The alloys also can be purchased in the open market containing about 30 per cent manganese either with or without iron, as desired.

Blow-Holes in Locomotive Brasses

We are experiencing considerable difficulty with heavy locomotive rod brasses, blow-holes developing only on the bearing side, which are about ⅛-inch in depth. We are using a mixture consisting of copper, 79 per cent; tin, 10 per cent and lead, 11 per cent. The mixture contains 50 per cent new metal and 50 per cent scrap bearings melted in an open-flame, gas-fired furnace, 1,200 pounds to the charge. Is this trouble caused by oxidation? The blow-holes have a reddish color underneath a soft skin. We never previously experienced this difficulty until we received a lot of pig tin which analyzed as follows: Tin, 97 per cent; lead, 3 per cent, with traces of antimony. We are of the opinion that the tin is causing our trouble. What is your opinion of this tin and what effect will it have upon a bearing metal subject to heavy duty?

We fail to see how the tin can be held responsible for the blow-holes appearing in the casting. If a price allowance is made for the lead, the tin should prove satisfactory from a metallurgical standpoint, as it is simply necessary to allow for the percentage of lead when figuring the mixture to get the same results as with pure tin. The blow-holes may be due to defective molding or to worn-out sand. Usually, however, blow-holes are produced by faulty melting, such as failure to keep the metal well covered with charcoal. It may be well to use a little phosphor-copper in connection with the mixtures; about one pound per 100 pounds of metal should be added prior to the removal of the pot from the furnace. If charcoal cannot be used in an open-flame furnace, use a flux of powdered glass with a little salt.

Use of Tobin Bronze Scrap

We have a large lot of Tobin bronze scrap in the form of shafting and turnings and we would like to know how this can be utilized in different mixtures. We manufacture stuffing boxes, eccentric straps, connecting rods, propellers and similar castings. Will lead soften Tobin bronze and does iron make the composition hard and brittle?

Tobin bronze contains approximately 40 per cent of zinc and no aluminum. Therefore, it can be used in any red brass or bronze mixture by adding a sufficient amount to equal the amount of zinc desired in the alloy. For example, if an alloy containing copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent, and lead, 5 per cent, is desired and assuming that the Tobin bronze contains 60 per cent copper and 40 per cent zinc, figuring the tin and iron as copper unless the copper of the particular alloy is definitely known, the alloy would carry 13 per cent of Tobin bronze, which would furnish the 5 per cent of zinc for the mixture and approximately 8 per cent of copper, which is subtracted from the total copper content. This does not take into account the amount of tin in the Tobin bronze, but if it is known that this amounts to 2 per cent, it should be also taken into consideration in making the red brass. Lead has a tendency to soften Tobin bronze and it will, of course, make the metal machine more easily. We suggest, however, that the Tobin bronze be used in your regular red brass mixture as a carrier of zinc rather than to attempt to make castings direct from the bronze scrap, because it is difficult metal to cast.

Condenser Tube Plate Difficulties

We are experiencing trouble in casting a solid condenser tube plate, 4½ feet in diameter and 1½ inches thick, the center of which develops a pipe when the holes are drilled for the tubes. What mixture would you recommend and what method of molding would you employ to overcome this difficulty? Would a chill over the center be of any value?

We presume that the casting is gated on the periphery, also that the risers are located on the edge of the casting, which appears to be a disc. The supply of metal for feeding shrinkage is thus at a considerable distance from the center of the casting. The center cannot get metal to make up for the shrinkage at this point, therefore there must be a void somewhere, which assumes the form of a split, because the congealing metal has built onto the cold surfaces of the cope and drag of the mold. The remedy is to feed the center, which may be accomplished by placing three heavy risers thereon, arranging them in a triangle to cover the center of the disc, but not bunching them too closely together.

There is a possibility that three risers will not be sufficient. Judgment, of course, will have to be used as to the size of the risers and their number; the difficulty of removing them will have to be considered and in this connection there is a possibility that the risers could be dispensed with by inclining the flask and running the metal in at the lowest edge of the casting so that it has to run up hill in the mold, and locating heavy risers at the highest point. There would then be a chance for the metal in the risers to drain into the crack as it formed. The runner heads could be built up so that the metal would just enter the risers. We doubt whether a chill over the center of the casting would eliminate the trouble.

Monel Metal Castings

We are experiencing considerable difficulty in making Monel metal castings. Regardless of our efforts, these invariably are honeycombed and we would like to know what kind of sand should be used. Also, let us know the type of furnace that should be employed.

Since Monel metal melts at a high temperature, the sand used for facing the molds should be sufficiently refractory to withstand this temperature without fusion. Otherwise, gases are generated which are injurious to the castings and the melted sand will fuse onto the surface of the metal, thereby causing other defects. Use a facing of silica sand, the more refractory the better. The following facing mixture will withstand the high temperature of Monel metal:

Silica sand, one wheelbarrowful; fire clay, three shovelfuls and flour, 1½ shovels. Mix with molasses water to the right consistency for molding and either dry or skin dry the molds before pouring the metal. To remove the gases from the metal stick magnesium may be employed, adding about two ounces per 100 pounds of metal.

Mixture for Phosphor Bronze

We would like to have a mixture for phosphor bronze.

For strong phosphor bronze the following alloy will be found to be satisfactory: Copper, 88.50 per cent; 15 per cent phosphor copper, 1.5 per cent, and tin, 10 per cent. Add the phosphor copper to the molten copper before adding the tin.

For a bearing metal the following is a good general mixture: Copper, 78 per cent; phosphor copper, 2 per cent; lead, 10 per cent, and tin, 10 per cent.

Close-Grained Copper Castings

We are experiencing difficulty in obtaining close-grained copper castings. Regardless of the expedients we resort to, the castings continue porous. To what temperature should the metal be heated and at what temperature should it be poured? The castings must be made of pure copper.

The copper will have to be degasified before it can be cast sound. This operation usually is termed *deoxidizing*, but since the gas holes are not always made by oxygen, the removal of this gas does not always insure sound castings. Some energetic deoxidizing agents fail to produce sound copper castings. If experiments have been conducted with various deoxidizers and failures have been recorded, the foregoing remarks will explain the reason. The most satisfactory deoxidizer for copper is silicon and its use in the present instance is advised. This will produce so-called pure copper castings, although if the conductivity is an essential feature, the amount of silicon used must be low.

The copper should be melted under a cover of charcoal 2 inches deep. Two ounces of common salt should be added for each 100 pounds of metal and this should be placed in the pot before the copper is charged. When the metal is molten and has a mirror-like appearance underneath its cover of charcoal, add six ounces of silicon-copper containing 10 per cent silicon and stir the mixture with a graphite rod. Do not skim off the charcoal before pouring and hold it back with a graphite skimmer to prevent the absorption of gases by the copper while it is being transferred to the molds. If six ounces of silicon-copper fail to produce sound castings, increase this amount up to 1 per cent. However, the increase in silicon will lower the electrical conductivity of the castings. While the metal should be fluid, do not overheat it and it should not be so hot that it bubbles.

Melting Aluminum Borings

Will you kindly advise me what is the best flux for melting aluminum borings and the best form of furnace for this purpose? How can the zinc be reduced in aluminum borings without much loss of weight? I would also like to have your opinion regarding the percentage of solid metal after melting this kind of material.

In a paper presented recently before the American Institute of Metals, H. W. Gillett recommends the addition of a flux consisting of salt and fluorspar to aluminum chips when the latter are to be melted. He says that the chips are intimately mixed before charging with large amounts (20 to 50 per cent of the weight of the chips) of a flux consisting of about 85 per cent of common salt and 15 per cent of powdered fluorspar. The mixture of chips and flux is placed in large crucibles and heated in a coke fire. As soon as the chips start to melt they are jammed down to make room for more of the mixture and this process is continued until the pot is full of metal. The temperature which the chips should attain is 900 degrees Cent., or 1,650 degrees Fahr. The recovery by this method is claimed to be from 75 to 85 per cent of the metal in the turnings.

Plaster of Paris Molds

How should plaster of paris molds be treated to permit of casting aluminum into them and to have the metal lie quietly in the molds?

The plaster mold should be thoroughly dried before it is used, otherwise it will blow. The drying operation requires considerable time, as the mold should be dried at a low temperature at first, and should be placed in a warm atmosphere, but not in a hot oven. After it is dried it should be placed in a muffle and slowly heated to redness. Unless this is done there is danger of blown spots on the casting. To successfully cast in plaster requires skill and experience. The plaster usually is mixed with brick dust, hard coal ashes or asbestos before being used to form the molds. A formula extensively employed for plaster molds consists of two parts of red brick dust and one part of plaster.

Casting Tobin Bronze

We would like to have some information regarding the method of casting Tobin bronze, as our results have by no means been satisfactory.

If the specifications will permit of the addition of a small amount of aluminum to the bronze, the production of such castings will be greatly facilitated. The difficulty experienced in casting Tobin bronze is common to all yellow brass alloys and is due to the volatility of the zinc oxide, which, if permitted to enter the molds causes defects. In the case of heavy castings the alloys containing high zinc, minus aluminum or silicon, burn into the sand. The mold should be washed with plumbago, skin-dried and the metal should be poured at as low a temperature as consistent with running the casting. The addition of 0.25 per cent of 30 per cent manganese copper will assist in running these metals, although not to the same extent and in the same manner as that effected by the employment of silicon or aluminum.

Porous Bushings

We are manufacturing bushings from an alloy of the following composition: Copper, 85 per cent; tin, 5 per cent; zinc, 5 per cent and lead, 5 per cent. These castings are required to withstand an air pressure of 90 pounds but are too porous to meet this test. The metal is melted in a natural draft furnace and the mixture is made from ingot metal entirely. Can you advise us the cause of this difficulty?

A careful inspection of the castings forwarded shows that they have been gated at the wrong end. The gate should not be on the flanged end, nor should the metal be directed straight into the mold. It has been found by experience that the metal will draw when the molds are so gated, unless an abnormally heavy sprue is used. The leaky spots are located where such a draw would be found. We suggest gating on the other end, that is, at the side and not on the end. The gates should be circular or oval, about ¾ inch in diameter and the sprue should be located as far back as the end of the core print and then should be connected by a heavy channel through the gate previously mentioned. The connection of the runner from the sprue and the gate to the casting should be at right angles. The metal itself is dirty, which induces leakage, and also it contains iron, which is not desirable for a mixture of this kind. If the metal is received in the form of ingots, ascertain whether the manufacturer melts in crucibles or in a reverberatory furnace. If virgin metals are being employed, be careful of the iron stirrers. Increase the fluidity of the metal by the addition of 0.25 per cent phosphor copper and coat the cores with dry whiting rubbed on by hand and dusted with a soft brush.

Alloy for Pump Piston Heads

We would like to have a good acid-resisting alloy for vacuum pump piston heads. The casting is 26 inches in diameter and 24 inches deep. This is cut into rings, which must be sprung onto the piston head. The metal should be sufficiently resilient to spring without bending. We also would like to have an acid-resisting metal for sulphide mills.

For pump pistons use the following alloy: Copper, 88 per cent; tin, 11 per cent, and phosphor-copper, 1 per cent.

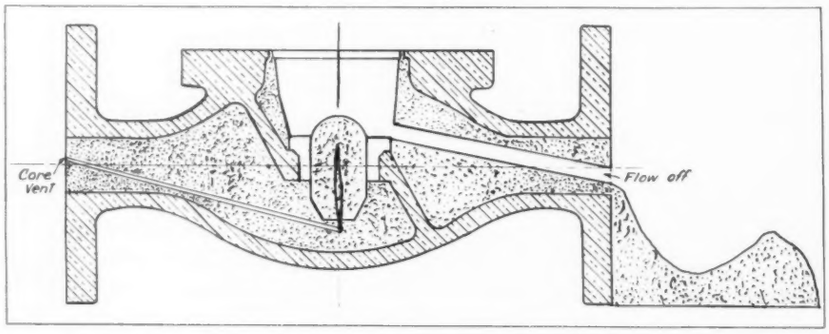
For sulphide work the following alloy is recommended: Copper, 83 per cent; phosphor-copper, 1 per cent; tin, 8 per cent, and lead, 8 per cent.

Burning-On Valve Seats

By J. L. Sendner.

The practice of repairing brass and bronze castings by burning-on is a long established and much practiced custom. Frequently, considerable valuable time and expense are saved by this process and some remarkable feats have been performed.

Recently our shop figured on making about 20 2½-inch globe valves for a marine boiler feed line, to replace a like number of valves whose seats were worn too much to permit of reseating. The installation of false seats was not considered owing to the danger of the seats loosening under the continuous dropping of the valve discs. We had no patterns or core boxes for these valves and as the patternmaking with the machine work would amount to considerable, we decided to try burning-on new seats in the old valve bodies. The accompanying sketch shows the method employed in preparing the valves for the burn. The bodies were thoroughly sand-blasted, after which they were taken to the core bench and given a thin coat of paste where necessary to keep the sand in position. Fine core sand was used and was built-up in the valve, as shown; then a core print was imbedded in the sand to allow for the introduction of a dry sand center core. The center core was used to lessen machine work and to assist in the proper cooling of the casting. A gate stick was rammed up in the body at the height of the burn desired and when withdrawn, it left the flow-off as illustrated. The valve then was placed in the oven and thoroughly dried, extra metal having been allowed in the burned-on part for finish; this is shown in the sketch as the part not etched, surrounding the center core.



CROSS-SECTION OF A BRASS VALVE, SHOWING HOW IT WAS ARRANGED FOR BURNING-ON A SEAT

Gun metal was used and was poured at a temperature from 2,400 to 2,600 degrees Fahr. About 100 pounds was cast in making each burn. This metal melted the old seat entirely and burned well into the walls of the valve.

One of the first valves burned after being machined and reassembled, was subjected to a hydraulic test of 400 pounds. After successfully withstanding this test, it was tested to 250 pounds steam pressure and while still hot was again placed under the cold water and tested at 500 pounds cold water pressure without showing any sign of leaking.

Great care must be exercised to have the core sand in the valve thoroughly dry and the burn must be made while the valve is hot, as the smallest amount of moisture will make a defective job.

Pertinent Pointers for the Care of Crucibles

The Joseph Dixon Crucible Co., Jersey City, N. J., is sending to the brass foundry trade a hanger which contains pertinent suggestions for the treatment of crucibles in foundry operations. On the reverse side of this hanger is given a table containing specific gravities and melting points of various metals, as well as a number of low fusion alloy mixtures. The suggestions with reference to prolonging the life of crucibles will prove of value to every melter and are as follows:

Refit tongs and shanks to crucibles every 30 days.

Keep fuel in a dry place, as damp or wet fuel causes scalped crucible.

Don't wedge the metal in the crucible.

There should be about 3 inches of coke space on the sides and 6 or 10 inches of fuel under the crucible, depending upon the size of the crucible.

Keep an accurate record of heats.

Store crucibles in a warm, dry place about two weeks, then anneal by heating very slowly and gradually—upside down, preferably—to 250 degrees Fahr. or over.

Where oil or forced draft is used, be careful about too much air pressure which produces an oxidizing flame, thereby eating away the plumbago in crucible.

Set the crucible in a bed of dry sand when removing it from the furnace and be sure there are no clinkers left on the bottom or sides of the crucible.

Don't leave the crucible in the fire after the metal is ready to pour.

If possible, recharge the crucible and put it back into the fire before allowing it to cool if an after-heat is to be run.

Don't leave metal in the crucible to cool.

Have shanks fit the crucible, but if clips have to be used be sure that they are sufficiently wide. Better use two sizes of shanks and don't use *gates* as clips.

Avoid hard, sharp pieces of coke under the crucible.

Be careful with the use of the poker; it is easy to punch a hole through a hot crucible.

Place the crucible in the center of the furnace so as to give equal fuel distribution all around.

Don't set the crucible in a cold draft or near an open door in the winter.

Avoid fluxes unless absolutely necessary.

Don't drop heavy pieces of metal into the crucible from a distance.

Don't drop large pieces of cold metal into a crucible containing molten metal, without first heating it, or it will *chill back*.

The top of the crucible should not be set higher than the bottom of the flue hole at the beginning of the heat.

Tapering of Core Prints

By F. J. Townsend

Should bottom core prints be tapered the same as top prints? This is a question which might appropriately be discussed by foundrymen generally. We are giving bottom prints only the slight draft used for patterns and if the change indicated be made we would like to know the reason therefore.

A claim to this effect is made in Chapter X of a book entitled "Wood Patternmaking", by Horace Traiton Purfield, as follows:

A great many castings are lost because the lower print of vertical cores are made nearly parallel, or with the ordinary pattern draft. The probable cause of this is that the core does not go down to the bottom of the mold since the sand is cut down by the core not setting; so, when the cope is closed, being too long, it breaks the mold around the print of the core, allowing metal to flow into the vent and thereby causing the casting to blow. This may be overcome to a large extent by tapering the lower print as is usually done in the case of the upper one. If this is attended to there can be no trouble in setting the core. Indeed in the case of small cores, the molder can set them enough faster to pay for the extra work of pasting such cores together. As this is the main objection to this shape of print, namely, the necessity of making the cores in halves, it will be more than overbalanced by the advantage of the greater facility and rapidity with which the cores can be set, to say nothing about the larger output of sound castings.

Recent Improvements in Foundry Operations---II

A Discussion of Molding Machine Practice, Sand Preparation and Quantity and Quality Production

By Thomas D West

ON THE machine shown in Fig. 11 the pattern is secured to a swing arm at its face *Q*. This arm is turned over by the cylinder *P*, which brings the face side *R* down onto the jar rammer *S*. The flask is placed over the pattern, and after the sand is jolted, to obtain the desired density, the bottom board is put on and all are clamped together, so that the swing arm may be brought back to the position shown. This done, the flask supports *TT* are raised by a piston at *U* to come up under the bottom board of the mold, represented by the dotted lines *V*, after which the turn-over frame, or swing arm *Q*, is released from the mold by freeing the clamps from the flask, and then the whole mold is gradually lowered by a descent of the piston *U*. This action draws the flask and mold down from the pattern, since the latter is fastened to the swing arm at *Q*. Turning this arm up to a vertical position, or allowing the face *R* to rest again on the jar rammer *S*, permits the removal of the rammed flask or mold, by hand or a crane, to any distant point on the floor of the shop. This is a pneumatic molding machine made by the International Molding Machine Co., Chicago, the ingenious arrangements of which have proved of much practical value in reducing the cost of making molds adaptable to its construction.

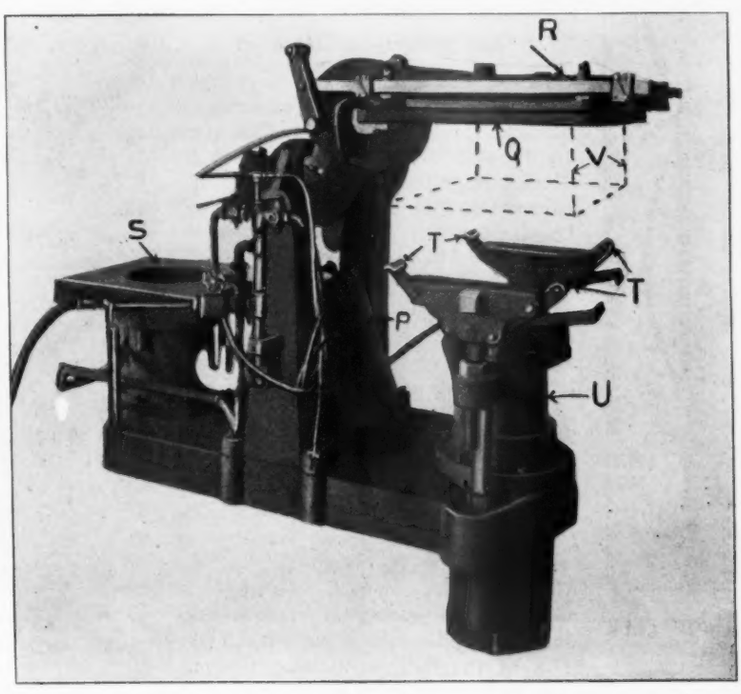


FIG. 11—INTERNATIONAL SWING-ARM JOLT-RAMMING TURN-OVER PATTERN-DRAWING MOLDING MACHINE

The first machine to be used for compressing sand in flasks is conceded to be of the type known as a hand squeezer. It was applied solely to the making of small castings. A good illustration of one of the latest improved hand squeezers is shown in Fig. 12. The mold board, pattern and flask are placed with the battens of the first named, resting on the table plate supports *A*. The sand having been filled into the flask, the machine operator pulls on the lever handle *B*, which brings down the squeezer plate *C* onto the top of a battened board covering the sand in the flask. Further pulling down of the handle *B* squeezes the sand in the flask, from the top down, to the desired density or to the power capacity of the machine. The vertical distance between the points *A* and *C* can be changed to suit varying depths of flasks by raising or lowering of the cross bar *D*, by adjusting the nuts *E* and *F*.

This type of improved hand squeezer has connected with it a pneumatic vibrator, shown at *G*. This appliance vibrates the table *A*, so that in drawing the pattern by hand it comes more freely from the mold, greatly decreasing any chance of its loosening or breaking any of its parts or joints. It also does away with the use of rapping bars, which often injure patterns and distort the size and form of the casting produced. The value of this device is especially evident in repetition work in making castings.

The principle involved in this vibrator is used in a variety of ways, on both hand and power molding machines of all classes, to aid the drawing of patterns. The introduction of the vibrator has made it possible to draw many deep patterns quickly, and also to draw those having complex contours, without breaking or starting the sand of the mold. Prior to the recognition of the principle, much trouble was often experienced in drawing such patterns without causing injury to the mold.

The great utility of hand squeezing machines soon led to the adoption of power squeezers of various pneumatic and hydraulic types, Germany leading in the use of the latter. A very simple and effective power squeezer, designed by W. D. Fraser, is shown in Fig. 13. In operating this machine, the mold board, pattern and flask, represented by the datted lines *H*, are set on the table-plate *I*. This table is cast solid with a cylinder *K*. The piston, which is 12 inches in diameter, is bolted to the base *N*. By turning the valve at *J* the cylinder rises from its faced point at *M* to any required amount up to 4 inches. The average required of the cylinder and table is about 1½ inches. While the cylinder-head table-plate *I* is only 15 x 21 inches, the machine, it is claimed, can compress the sand in a flask as large as 24 x 30 inches. By turning the top plate *P*, the distance between it and the table plate *I* is varied to take any height of flask within the machine's range. To admit of placing flasks and filling them with sand, the arm *R* is swung to one side, and when returned to its working position, it is locked by means of the handle *S*. This machine also has a vibrator, as shown at *O*, which is controlled by the valve at *L*. Both these hand and power squeezers are made by the Berkshire Mfg. Co., Cleveland.

For castings of certain designs, and to suit certain shop and other conditions, it is sometimes very desirable to first jolt-ram the sand and then finish its compression by a squeezing operation. This has the effect of creating a uniform, vertical density of the sand, similar to that obtainable by gravity ramming, the chief difference being that any desired degree of variable hardness

is better obtainable throughout the depth of a mold by this combination than by gravity ramming. This method also saves much jolting that might be detrimental to the life of a pattern or flask.

A combined jolt and squeezer machine is shown in Fig. 14. The cylinders *T* and *U* are pattern-draft cylinders used for lifting the table or flask frame *V*, which carries the mold up and away from the pattern after it is rammed. The patterns are mounted on a pattern plate, resting on the jolt table, and shown inside of the frame *V*. A vibrator is attached to the pattern plate. The jolt mechanism is placed in the center of the squeezer cylinder *W*. The squeezer beam *Y* drops back to permit the placing and removal of flasks. This machine, which is manufactured by the Mumford Molding Machine Co., Chicago, takes a flask 18 x 26 inches, and operates with air

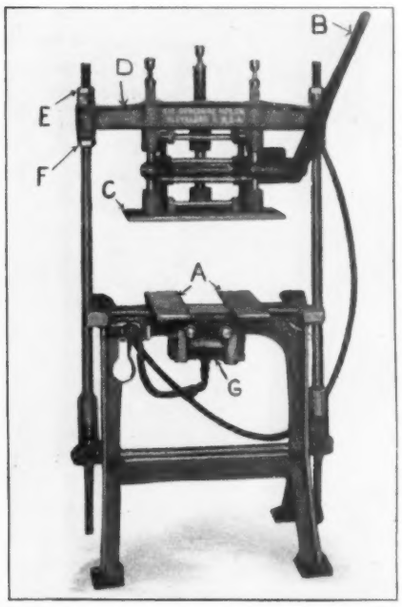


FIG. 12—BERKSHIRE HAND SQUEEZER AND VIBRATING MACHINE

at 80 pounds pressure. The principle involved in this combination machine can be utilized for varied forms of flasks or patterns.

While Fig. 3, in the December issue, showed the principles involved in gravity ramming of molds, it will be of interest to consider the appliances which make the principle applicable for use in founding. With this in view, attention is directed to Fig. 15. In operating these machines, the sand is shoveled or dumped into a hopper bin from which a line of buckets, attached to sprocket chains, conveys it up to a height, from which it drops into the flask. This flask is suspended by hanger rods, which operate like a swing or cradle, permitting it to be moved in or out to catch the falling sand at any desired point in the flask, until it is filled with packed sand all over its area and to the desired height. To swing the flask, or the cradle, in or out, as desired, in order to have the dropping sand land at the right spot, the swing of the cradle is controlled by hand for light work, and for heavy work, it is controlled by an extending arm operated by an electric motor.

The flask, cope or drag, as the case may be, when rammed, it turned over in the cradle, let down on rests, unclamped, and the cradle, with the pattern board attached, is then drawn from the sand or flask by the power of the machine. The flasks are carried away from the machine by a crane to the floors where they are cast. The manufacturer of this machine, the Buch Foundry Equipment Co., Bridgeport, Pa., claims to have them in use making various different kinds of castings at a reduced cost, as compared with hand labor. The construction of this machine is unique and ingenious.

Roller Ramming Machines

In the description of Fig. 2, reference was made to recent achievements in utilizing a roller to pack sand in flasks. In starting to make a mold on the McDonald, patent, roller ramming machines, the flask is placed on the mold board or match plate, after which the roller guide and sand frame is lowered to place. After the flask has been filled with sand, the roller is driven forward and backward by an air cylinder operated by a valve. The flask having been sufficiently rammed, the roller guide is raised, and the flask is struck off and lifted off from the match plate or pattern, thus completing the operation of ramming a drag or cope.

An angle iron track serves as a guide for the roller and also as a means for retaining the sand on top of the flask while it is being rammed. If there were no means for holding the sand in sideways, the roller would push it off the sides of the flask as it travels along. The flange of the roller is somewhat less in diameter than the main cylindrical part of the roll. The difference in these diameters is double the thickness of the horizontal legs of the angle iron track. The vertical legs of these angle irons, when in use, project into grooves adjacent the main cylindrical part of the roll. This serves to guide the roll and to allow it to ride freely upon the sand. When the roll is off of the flask and going back to its initial position, its weight is carried on other supports. These supports also serve to prevent the roll from dropping down into an empty flask and thereby breaking out the bars, in case the operator should run out the roll before the flask was properly filled with sand.

The sand-retaining feature of the angle iron track is a most important one, as it enables the sand to be properly rammed at the edges of the flask, without hand tucking or hand ramming, preliminary to rolling the mold. Another important feature is the strike-off, which travels in front of the roll and is supported by small wheels. This strike-off has a profile shape similar to the design of the pattern, and is so designed as to leave more sand over the longitudinal deep parts of the mold and less over the shallow parts, thereby insuring uniformity of ramming. This strike-off is so constructed that its position is independent of the vertical position of the roll itself, so that as the roll lifts up on the sand, while it is ramming the mold, the strike-off stays at a constant level.

Another ingenious arrangement is used for ramming evenly where there are uneven contours to the face of a pattern, or where it has large projec-

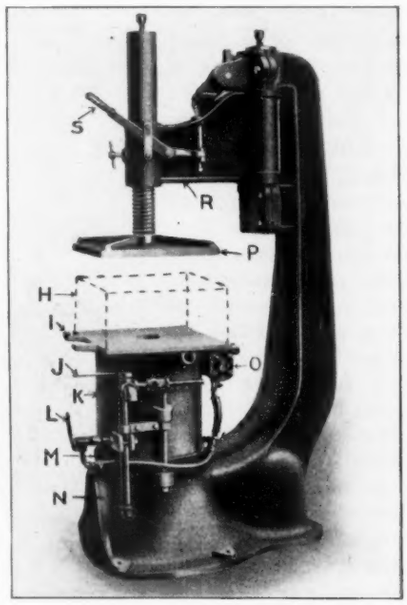


FIG. 13—BERKSHIRE POWER SQUEEZER AND VIBRATING MACHINE

tions which protrude above its general level. This method consists in using a flexible pad—composed of strips of oak, about 2 inches thick, bound together with steel cables running the entire length of the pad—which is placed on top of the sand that has been struck-off to a level surface. The underneath side of this pad is cut out to conform approximately to the contour of the pattern, so that when the roller is reciprocated to and fro over the pad, there is produced a more even density of the compressed sand than would be the case if a strictly level faced pad were used. Tables are used so that stripping plate patterns can be employed when desirable, a method followed in many instances.

The larger-sized machines are electrically, and the smaller pneumatically, driven. The power, or rather the amount

of air required for the pneumatic machine, is about 3 cubic feet, at 80 pounds pressure, per half mold, 20 inches wide and 42 inches long. A three-horsepower motor is used on the electrically-driven machine, having rolls 30 inches wide, and such a machine is claimed to ram a flask 8 feet long in about 25 seconds. The power required for machines of other sizes is in proportion. These machines are built by the Snead & Co. Iron Works, Jersey City, N. J.

The ability to ram molds quickly by machines demanded the creation of ways and means to mix and supply the sand quickly to them. As a result, there has followed in the wake of molding machines, the devising of various methods for mixing and conveying of sand to them, and also for general floor molding purposes, that should prove interesting and profitable to many engineers and founders. One of the first steps toward the installation of auxiliaries, to co-operate with molding machines in reducing the cost of making castings, was the introduction of sand-screening and mixing appliances, of which there are numerous different designs in use at the present time. One of the most recent machines for this purpose is shown in Fig. 16. The sand is fed by a shovel, chute, or otherwise, into the open end, at *A*, against a disc inside of the screen, which breaks it up and scatters it around the screen's circumference as it revolves. Any refuse or pieces of iron, etc., that will not pass through the size of screen used, pass out onto a chute, or drop to the floor at the end *D*, to be carried away by a wheelbarrow or other means. The sand drops from the screen *B* into a mixing trough *E*, in which there are a series of right and left hand paddles, which are revolved by the gearing *F*. These paddles give the sand or sands a thorough mixing while being moistened with water, oil or any liquid compound from the reservoir *C* through the pipe shown below it. After a batch of sand, whether for facing or cores, has been sufficiently mixed, it is discharged from the trough *E* by means of the lever *G*, which opens an outlet at *H*. The sand can be carried away from the machine by wheelbarrows or a chute. There are five sizes of these machines now obtainable. Some dimensions of the smallest are marked on the illustration. This machine mixes 4 cubic feet, and the largest size, 27 cubic feet, of sand per batch. The floor space required for the smallest is 2 x 6 feet 9 inches, and for the largest, 4 feet 9 inches x 11 feet 10 inches. The power required to operate the smallest is 3-horsepower, and for the largest, 25-horsepower.

Value of Unit Systems

Progressive founders, shortly after the introduction of this class of machines, realized that it was possible to have machinery to shake-out the castings and mix and convey the sand any distance, resulting in increased economy of operations. The past six years have witnessed many ventures to achieve these ends, some of which have proven costly failures. The results have been of great value, however, especially in the designing of sand-mixing and conveying plants in specialty foundries. These past experiences have caused the development of what is now known as the unit system. This means making two or more divisions of a specialty shop and having an independent casting, shaking-out, sand-mixing and conveying plant for each section of the shop, so that if one unit or section breaks down, the whole foundry is not crippled. The designer and constructor of this system is the Standard Sand & Machine Co., Cleveland, which is also the manufacturer of the appliance shown in Fig. 16.

To follow the operation of this system, we will take as an example a large steel foundry, whose product is, principally, one class of steel castings. The molds are made in green sand. To shake the castings out of the flasks, they are brought, four at one time, by a specially arranged crane beam to a steel casting shake-out table, which is a practical and novel device. The castings are pulled from the table by hand and the sand is dropped through the grating *I*, Fig. 18, into a hopper. This hopper holds 10 or more tons of sand, which is fed out of it by means of two 16-inch heavy steel screw conveyors, *J*, and falls through an opening *K*, at the front end of the hopper, onto a 30-inch wide six-ply rubber-belt conveyor *L*. A plan view of the shake-out table and belt conveyor would show the former situated in a side wing, permitting the jarring machine to have a foundation directly under one end of it and leading down to solid earth below the floor of the belt conveyor's tunnel, which is 60 feet long. The sand having been brought to the end of this belt, at *M*, drops onto a chute *N*, which carries it down to and into the boot *O*. The pulley *R* is magnetized and holds any iron that may be in the sand on the belt *L* until it falls to the chute *P*, from which it passes to the floor at *Q*. From the boot *O*, the sand is carried up by means of a 16-inch six-ply rubber belt *S*, having 14-inch sand buckets *T*, to the spout *U*. From this it passes to the revolving screen *V*, which removes any wood chips or wedges that may be in it, besides screening it free from other refuse.

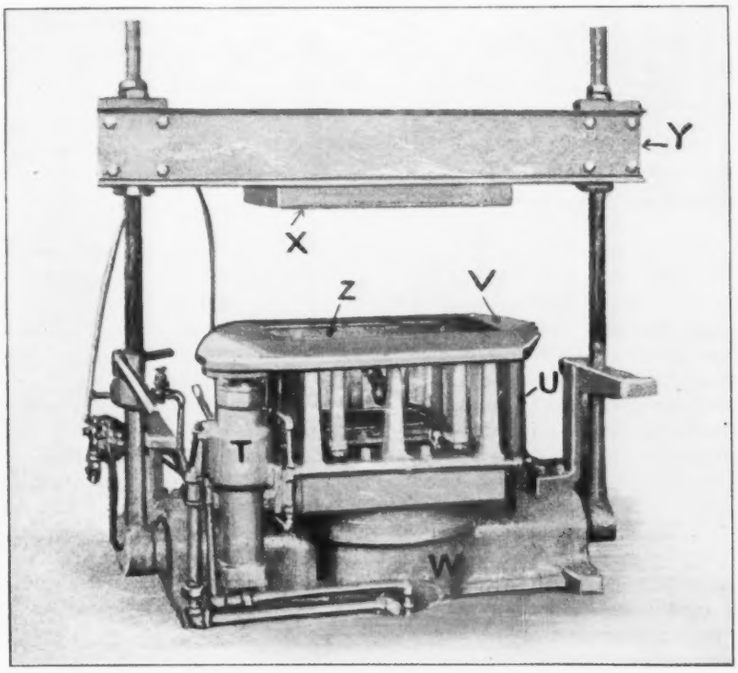


FIG. 14—MUMFORD COMBINED JOLT AND SQUEEZER RAMMING MACHINE

This screen delivers the sand to a mixer *W*, from which it travels along the chute *Y*, to a boot, *X*. It is then conveyed to spout *A*, by means of another 16-inch six-ply rubber belt *B*, having 14-inch sand-carrying buckets, *C*. The sand falls from *A* into a drag conveyor *D*, and is then delivered to the spouts *E*, of which there are six in this unit system. These spouts are 6 feet 5 inches apart, and hold about 2½ tons of sand each, which is delivered to dump buckets *F* by opening a gate controlled with a hand chain on the wheel *G*. In future installations the dump buckets and crane will be dispensed with and a conveyor, of a drag or belt form, will be used to carry the sand from the spouts directly to

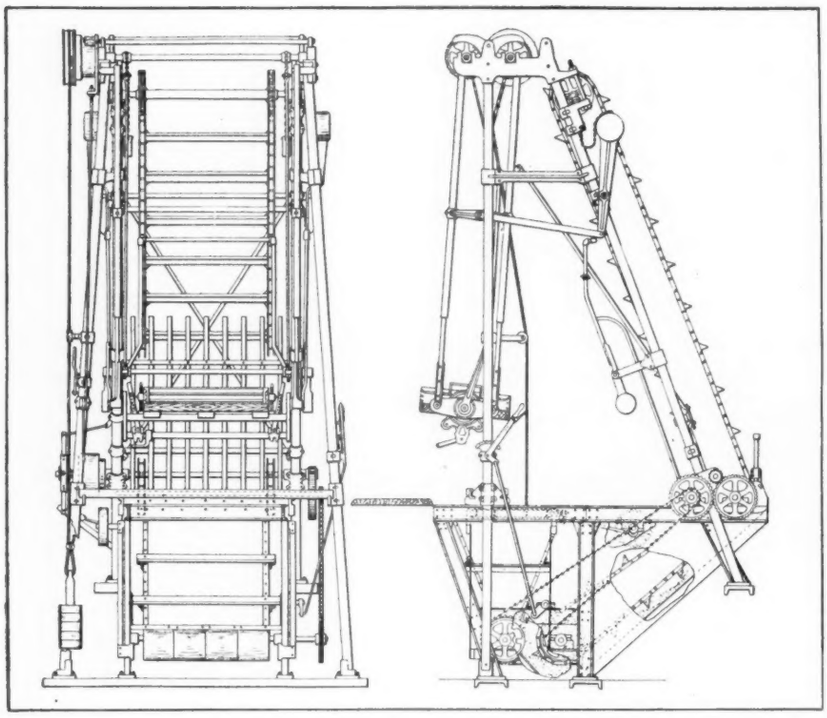


FIG. 15—BUCH GRAVITY RAMMING MACHINE

where it may be needed for filling the flasks. The unit system described required one 5-horsepower motor to drive the long upright belt *B*, and another of the same power to move the drag conveyor *D*. A 10-horsepower motor is required to operate the screw conveyors *J*, and one 25-horsepower motor is required for the remainder of the equipment.

Mixing Sand Heaps on the Floor by Machines

The past few years' endeavor to invent appliances for mixing sand ready to be rammed into molds has resulted in the development of power machines which dispense with the use of the hand shovel to a surprising extent. It would seem that there now are machines for mixing sand, that are suitable for almost any conditions. Together with successful drag and belt conveying apparatus there now are auxiliaries, in the form of independent machines, which will mix or "temper" sand without removing it from the floor where it has formed molds.

An illustration of this innovation is exhibited by what are called "auto sand cutters", constructed by the Sand Mixing Machine Co., New York, and shown in Fig. 17. These machines best serve their purpose where there are regular, uniform sand heaps, free of scrap that might injure the blades and with few, if any, obstacles in the form of columns, flasks, shop appliances or uneven floors to prevent the machine being readily taken from one sand heap to another, or where conditions exist similar to those usually found in light-work and stoveplate shops. To meet the objection that obstacles prevent moving these "auto sand cutters" around conveniently, a machine has been constructed, which can be operated advantageously when suspended from a crane.

In using the floor or the crane machines, water is thrown on the sand in the old-fashioned manner, after which the edges are shoveled in by hand, to roughly gather all the sand of a floor or heap in one windrow or long, raised pile. This done, the machine is brought over one end of the pile and its cutting operations started. If it is an ordinary molding floor, such as used for general light work or stoveplate, and the sand is properly wet down in the beginning, only one cutting over by the machine generally is necessary. In the case of bench molding, the sand, after being wet down, is shoveled up in a rough windrow and the machine started at the end nearest the bench. The machine moves a sand heap ahead about 4 feet at each cutting. Both the auto and crane sand-cutting machines have been found to produce a more uniform "tempering" of sand piles than is usually secured by hand shoveling and generally they greatly reduce the cost of such work. The motive power of the floor auto and crane sand-cutting machine is electricity. The requirements are for from 5 to 10 horsepower, according to the size of the sand heaps.

Mixing, Conveying and Packing Sand

The claim no longer is made that progressive foundrymen are not as wide-awake and ready to take every advantage of machinery as are the leaders in other vocations. The recent adoption of grab buckets to mix sands, etc., further displays their readiness to take the greatest feasible advantage of ways and means to reduce labor costs and hard work by the use of machinery, consistent with the production of good castings.

By means of a grab bucket, designed and built by the Pawling & Harnischfeger Co., Milwaukee, a sand heap, as one example, 80 feet long, 4 feet high and 5 feet wide, after being wet down, has been thoroughly cut, or mixed, ready for the molder in 35 minutes, utilizing only the labor of one crane operator and one man who handled the

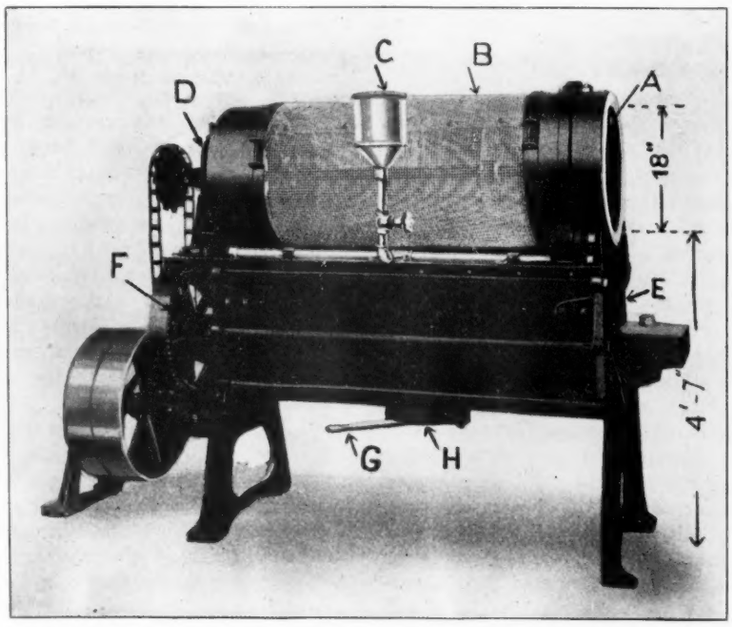


FIG. 16—COMBINED SAND SCREENER AND BATCH MIXER

rope that opens the buckets. After the sand has been wet, the mixing is done by raising it and letting it drop from a height. In wetting, prior to starting the operation of the grab buckets, sufficient water may not have been thrown on it to bring it to the desired "temper". In this case, more water can be sprinkled on, as needed, between the two or more successive hoistings required to give it a thorough mixing. The number of necessary lifts and droppings will depend greatly on the skill in applying the water and upon the character of the sand, as some grades are always harder to mix than others, whether the mixing be done by hand or power.

Bucket for Filling Flasks

These buckets also are employed for conveying the sand any distance and for filling large flasks. Their value in the latter use is increased by the fact that sand will pack itself to a greater or less degree, according to the height from which it is dropped. Large flasks may be partially rammed in this way. Again, these buckets are found to be of value in excavating and filling holes in floors of shops that do much "bedding in" work, as it is here that falling sand, packing itself, required little other manipulation. The grab bucket co-operates with the magnet in unloading cars, thereby assisting reduction of cost in handling raw materials; and both are appliances which may well be classed as having forwarded the art of founding.

Foundrymen of all the various branches and specialties of iron, steel, malleable, brass, aluminum, white metal and other alloy castings, while

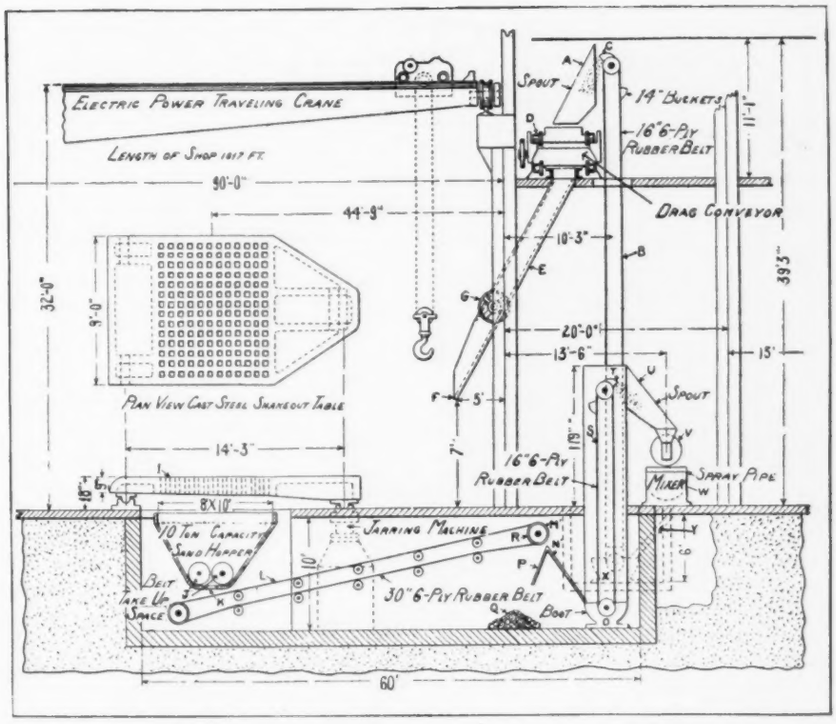


FIG. 18—DETAILS OF UNIT SYSTEM AND PLAN OF SHAKE-OUT TABLE

they have utilized the molding machine and sand mixing appliances in many ways, are to be commended for not having sacrificed quality to quantity. Quality has kept pace with quantity, so that, today, castings of all classes have an exterior appearance and internal solidity greatly superior to that obtained 10 to 20 years ago.

The improvement in quality has been brought about largely by the five following factors:

(1)—By a better understanding of the technical features of founding, largely secured through the liberality of experienced men and close students who have disseminated their knowledge and advanced ideas on the art by means of association papers and original, practical writings published in books and by the technical press.

(2)—By the employment of brainy supervisors who are ever seeking improvement and who possess the executive ability required to achieve desired ends, combined with broad experience as foundrymen.

(3)—By specializing and using the grades of sand and facings most suitable to the particular line of castings produced, by employing scientific methods in mixing and fusing of metals, and by using the best modern appliances to clean the castings.

(4)—By the use of molding machines, which permit many thousand tons of perfect castings to be made daily by machine operators or "handy men"; castings that otherwise could not be obtained readily, if at all, because of the great scarcity of good, skilled workmen and necessary executive molder foundrymen to supervise their labor.

(5)—By the installation of sand mixing, screening and conveying systems and sand-heap cutters that insure a better "tempering" than is generally obtainable by hand labor.

Future Foundry Operations

The number of skilled molders is not increasing as rapidly as the demand of the trade. This is so true that were there not machines and "handy men" to help make the many

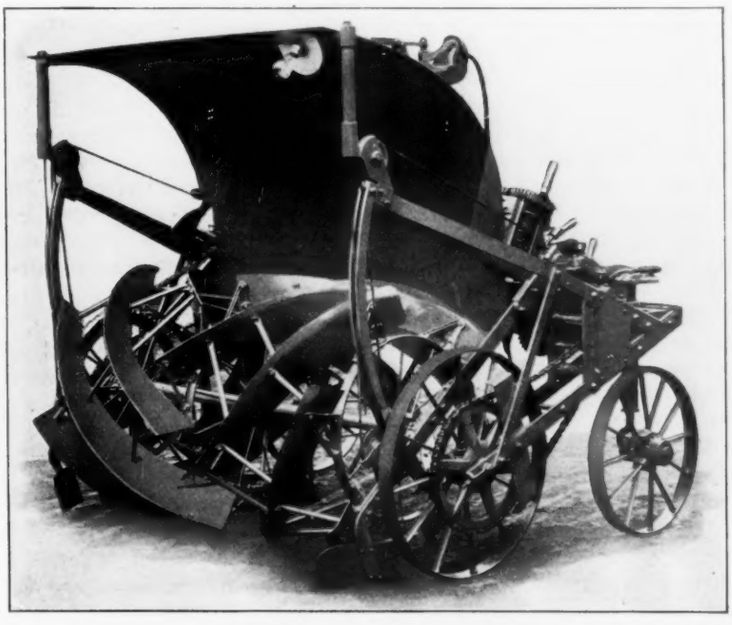


FIG. 17—FRONT VIEW OF AUTO SAND-HEAP CUTTING MACHINE

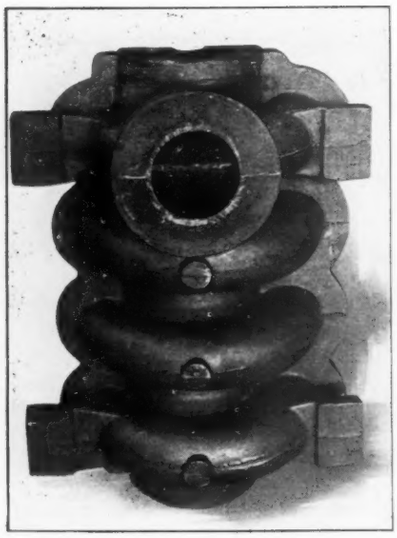


FIG. 1—VOLUTE PUMP CASTING

thousand tons of castings that are being turned out at this time, foundry operations would be in a sorry plight. It would be impossible to meet the demand for skilled molders.

The growing scarcity of skilled molders and efficient molder-founder executives is partly, if not largely, responsible for the development and introduction of the molding machine and auxiliaries as found in many foundries today. Nevertheless, as there is a limit to the provision of substitutes for skilled artisans and broadly experienced supervisors in founding, there should be some radical measure adopted that will insure the production of expert workmen and molder-founder executives. If this way is not opened, the art of founding must soon further pass away. It then will be still more difficult to obtain the skilled workmen that are necessary to produce certain lines of castings. It will be a much harder task to find efficient, shop-trained production managers. Such a condition is bound to have a most detrimental effect upon the whole casting industry, upon general engineering, and upon the prosperity of the masses.

An Intricate Pump Casting

The accompanying illustrations show an interesting casting which recently was cast at the plant of the Barlow Foundry Co., Newark, N. J. It is one of two castings required for a new type of automobile fire engine pump which was designed by L. Lawrence & Co., Newark. The casting was made in a dry sand mold consisting of a drag, a cope and three cheeks, not counting cheek extensions to the cope and drag. It was poured through four gates, two leading to the bottom flanges of the casting and two to the top flanges, all being fed from a basin at the top of the mold.

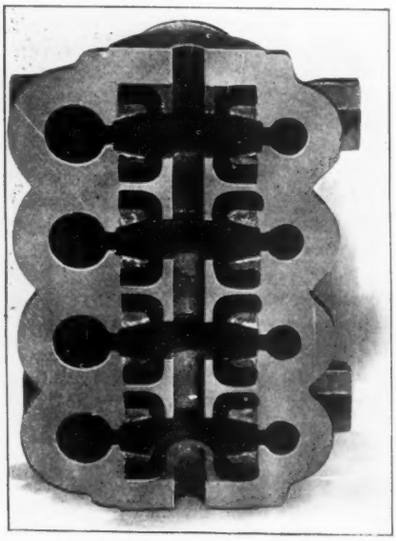


FIG. 2—INTERIOR VIEW OF THE CASTING

The mold, which was made in a square cast iron flask, was provided with cinder vents each approximately 2 inches square; the vents extended vertically through the cheeks, discharging at the joint between the third cheek and the cope. The mold also was provided with a riser joined to the hub of the casting. The job required 16 cores, the core boxes being shown in Fig. 3. This view also shows the pattern, which is in eight parts.

The mate to this casting was made in precisely the same manner; it was somewhat heavier, however, being provided with two additional hubs for flanged pipe connections.

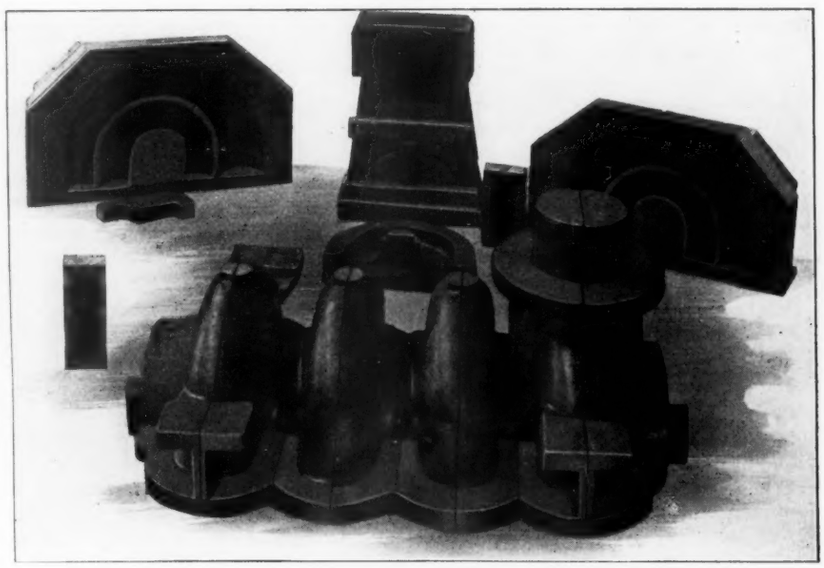


FIG. 3—PATTERN AND CORE BOXES FOR VOLUTE PUMP CASTING

Paint-Dipped Iron Castings

Question:—We dip gray iron castings in paint, but this does not dry sufficiently hard and glossy for our purpose. Would it be advisable to pickle the castings before they are dipped and, if so, what mixture should be used? Also, we would like to dip our castings only once in place of twice and we would like to have you suggest a method by which this can be done satisfactorily.

Answer:—If we knew the size of the castings and the nature of the paint used we could reply more specifically. The paint may not dry sufficiently hard and glossy for one or both of two reasons. Either the castings are not thoroughly dry when coated, or the paint is not of proper quality for the purpose used.

If the castings are brushed with a circular, steel scratch brush and then dried in 200 degrees of heat for from 30 minutes to one hour, no difficulty should result from moist castings.

If a varnish paint or enamel, prepared from colors ground in japan is used on dry castings, the coating should be hard and glossy.

Possibly insufficient time is allowed for the paint to dry and the paint is too thin.

We would advise you to avoid pickling if you can obtain a clean surface otherwise. Pickling will give you a clean casting, but the acid must be thoroughly removed from the pores by boiling water which will cause friction on the surface and draw the acid to the surface, or by a strong jet of water after which the casting is immersed in a bath of hot lime water and allowed to remain until the casting is the same temperature as the bath. This is done

to neutralize the acid not removed by the water jet. Then the casting is dried in an oven, the adhering lime brushed off and the casting should be painted immediately as rust will begin to form in one hour. Paint on over-pickled iron will never prove satisfactory, even though the above precautions are observed.

Sulphuric acid diluted with water is best for pickling gray iron castings and is used according to the condition of the castings and time available. A 25 to 28 per cent acid solution used hot is quite effective. Strong, hot solutions are advised.

Ten to 12 per cent acid solutions are too slow for economic treatment of commercial work.

Pickled iron is liable to become coated with a tough, gummy substance very difficult to remove except by the water jet or boiling treatment. Arsenic in the sulphuric acid made from pyrites also adds to the gummy deposits precipitated on the metal. Therefore, acid free from arsenic should be specified for the pickle. The gummy deposit prevents the paint from bonding to the metal. A small sand-blast is preferable to the pickling vat.

To reduce the dips from two to one will no doubt require a heavier paint mixture than you are using. The properly dried casting will assist also, as better results are obtained from one coat. If you are using a black paint, try the undiluted asphaltum enamel. It is durable, dries hard and with a good gloss.

If the castings are large the paint necessarily must be thinner than could be used for dipping small castings, as the runs on the lower portion must be avoided. Also, small castings can be finished with more gloss with only one dip than a large casting, as the heavier or less diluted the mixture, the glossier the finish, assuming that varnish paint or enamel is used.

Ample Light as a Factor of Safety

AN IMPORTANT factor in the prevention of accidents in foundries, namely, ample lighting facilities is discussed in a bulletin issued by the committee on safety and sanitation of the National Founders' Association. Attention is directed to the fact that more accidents occur on cloudy than on fair days and more workmen are injured in poorly lighted workshops than in well lighted plants.

When new buildings are under construction no extra expense usually is involved in providing sufficient window space. The problem of admitting ample daylight into existing buildings, however, may often present construction difficulties and entail considerable cost; yet in most cases, the resultant safety and welfare of workmen alone is worth the effort and outlay. Furthermore, in well lighted workshops a better class of employes can be secured, more and better work can be done and the expense for artificial light considerably reduced.

In many factories, but particularly in foundries, the problem is not that of securing more window space, but rather of securing more lighting service from the window space already available. Many foundrymen have the impression that, because the smoke and sand incidental to foundry work rapidly coat the windows with soot and dust, it is not economical nor even practicable to keep foundry windows clean. This is a mistaken idea, for in hundreds of foundry buildings of every kind and size the windows are kept comparatively clear of dust and soot. Without exception, employers who insist upon this condition are enthusiastic in praise of the results attained.

The method of cleaning windows varies with the size and condition of the buildings. In some large plants a man is especially employed for the daily cleaning of windows; in others and particularly in small foundries, the work is done at stated intervals, mostly on Saturday afternoons when the cleaning does not inconvenience other employes nor interfere with other work. Conditions in some foundries require that the windows be cleaned only two or three times a year, but even in such cases some windows should be cleaned much oftener than others because they are located where dirt collects quickly, as above cupolas, furnaces or core ovens.

When windows in a foundry are not cleaned for a long period, the glass often becomes rust-pitted, almost entirely opaque, and therefore useless for the admission of light. It is impossible to clean such glass and there is no remedy except to renew it; the result, however, is worth the cost.

Properly Located Windows

With the constantly changing position of the sun during the day, there may be periods when the light will stream through shop windows with such intensity as to be harmful to workmen's eyes, unless the position of their machines or benches is so arranged as to allow them to work with their eyes shielded from the bright glare. In some foundry work, however, it is impossible for employes to do their work in a fixed position; when, under these conditions, the glare is so intense as to be troublesome, the strong sunlight may be considerably diffused by whitewashing or painting the glass white, or by replacing the clear windows with ground or ribbed glass. Ribbed glass, when kept clean, will also introduce more light into buildings per square foot of window space than clear glass.

Ample and properly located windows, even though kept reasonably clean, will not alone solve the problem of effective shop lighting. Much of the light will be wasted if it strikes dark walls, posts or ceilings which would absorb a great deal of the light; whereas, if they were white or light in color they would reflect the light in diffused form. In this particular also the foundry presents greater difficulty than other workshops, for the same kind of dust and smoke that settles on foundry windows darkens the walls and ceilings. These should be cleaned down frequently by brush or air, and periodically whitewashed or given a coat or two of cold water paint. Where this has been done, it has been found to be practicable and profitable, and has added to the safe and sanitary condition of the shop. Sometimes the lighting conditions in foundries can be improved considerably by a rearrangement of partitions, flasks or other materials which obstruct the light; where possible, such paraphernalia as are not needed from day to day in the foundry should be removed to the foundry yard or stored in other suitable places.

Dark passages or poorly lighted stairways have proved to be a particularly fruitful source of accidental injury.

Ample natural light should be admitted to all stairways and vestibules wherever practicable, care being taken to so direct the light that strong shadows will not be cast at the foot of or at the head of stairs, as otherwise persons may miscalculate distances and thus miss their footing, fall, sprain their ankles or otherwise injure themselves.

W. E. Baird, formerly affiliated with the Robeson Process Co., New York, now is associated with the American Gum Products Co., 200 Fifth avenue, New York City, in charge of the sale of its binder for the production of cores.

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Prospect and Retrospect

WHAT a difference twelve months make! To have predicted one year ago the wonderful revival of business that has since taken place would probably have resulted in subjecting the prophet to a commission of inquiry and to foreshadow still greater activity throughout the first half of this year seems almost without the pale of reason. Yet there is every indication that the pig iron production during the next six months will set a new high mark that will exceed the figures of the most optimistic and since the iron output is the barometer of the casting industry, the melt will be at a record pace. For the first time in half a decade, gray iron foundries are compelled to defer deliveries from two to three months, and steel casting plants, particularly those serving the rolling mill industry, are from four to five months behind in their deliveries. The railroads, alone among the large consumers, are conspicuous by their absence from the market. Prices undoubtedly are too high to invite purchases of rolling stock, but one year ago, the complaint was inability to finance. It is certain, however, that with practically every car in service, large purchases will be forced before the end of the year, regardless of price. Early in 1915, gray iron shops were operating at about 40 per cent of capacity; malleable foundries were down to 35 per cent; steel casting plants did not average more than 30 per cent, while the brass and aluminum foundries specializing in automobile work approached normal with a melt averaging from 65 to 70 per cent. The heavy buying of machine tools for shipment abroad, which set in early in the spring, marked the beginning of an avalanche of orders which turned the tide from depression to prosperity. Then followed heavy purchases of steel for shell manufacture, never before parallelled in the history of the nation's principal industry, and the needs of the warring nations started into motion the wheels of industry which had been idle for nearly two years. The rapid advances in prices of raw materials entering into the manufacture of castings were keenly felt by foundrymen who were carrying yearly contracts at low prices and many of those who had previously covered their needs were unable to take new business on the attractive basis offered. Notwithstanding the ease with which orders for castings can be obtained, the high cost of raw material is a problem that is perplexing casting producers, and there is every indication of further advances during the first six months. The following comparison of pig iron prices a year ago with those prevailing today, show the tremendous advances that have been recorded:

	Jan. 1, 1915.	Dec. 30, 1915.	Increase.
No. 2 foundry, Chicago	$13.00	$18.00	$5.00
No. 2 foundry, Cleveland	13.25	18.80	5.55
No. 2 foundry, Buffalo	13.00	18.00	5.00
No. 2 foundry, Pittsburgh	13.70	19.45	5.75
No. 2 foundry, Philadelphia	14.25	19.75	5.50
No. 2 foundry, Birmingham	9.50	14.50	5.00
Lake Superior charcoal, Buffalo	15.75	19.00	3.25
Lake Superior charcoal, Chicago	15.75	19.25	3.50
Malleable, Chicago	13.00	18.00	5.00
Malleable, Pittsburgh	13.70	19.45	5.75
Malleable, Philadelphia	14.50	20.50	6.00
Basic, Pittsburgh	13.45	18.95	5.50
Basic, Eastern Pa.	13.50	18.00	4.50

The foregoing advances do not begin to parallel those made in the non-ferrous metals, copper, zinc and tin having made notable strides towards the establishment of high marks.

Death of Horace W. Knight

Horace W. Knight, Seneca Falls, N. Y,. pioneer manufacturer of pattern letters and figures, died in a hospital in that city Wednesday, Nov. 24. Mr. Knight began the manufacture of pattern letters and figures in 1863 and was the first to engage in this line of work in the United States. Mr. Knight was born in Mayfield, N. Y., in 1839, but in 1859 his family moved to Seneca Falls. Shortly thereafter Mr. Knight entered the office of the *Seneca County Courier*, where he learned the printer's trade and subsequently he became owner of this publication. He is survived by four sons, H. DeLancey, Willis G., Homer L. and Dr. Robert Knight, as well as three brothers. During the past thirty years the sons of Mr. Knight have been associated with him and will continue to conduct the business which bears his name.

Why Graphite Products Have Been Advanced

Recently sharp advances have been made in the prices of crucibles and graphite products generally and unless the supply of Ceylon plumbago increases, it is probable that still higher prices will maintain throughout the duration of the European war. The raw material from which crucibles, foundry facings, stove polish, etc., are made has more than doubled in value in the last 15 months. For example, at the time when war was declared so-called No. 1 lump Ceylon plumbago sold at wholesale in New York at 8½ cents per pound, whereas today it is quoted at 21 cents per pound. Ceylon plumbago dust, which enters largely into the manufacture of foundry facings, likewise has been advanced, so-called superior dust having been increased from 4½ cents to 8¾ cents per pound; so-called good foundry dust from 3 cents to 5½ cents per pound, medium foundry dust from 2½ cents to 4¼ cents per pound and ordinary foundry dust from 2 cents to 4¼ cents per pound.

Freight and Grinding Cost

To the cost of this raw material must be added the freight from New York to the various plants making foundry facings, the cost of grinding, handling, etc., which is estimated at 1 to 1½ cents per pound. When war was declared all of the German vessels dropped out of the far eastern trade and freight rates immediately were advanced. At the same time the price of the material was marked up because of the small stocks at Colombo and by the middle of October last year, prices had increased fully 25 per cent. During the latter part of October, 1914, the British government placed an embargo on the shipment of plumbago from Ceylon to this country and this was rigidly maintained until late in April this year. Throughout this period little or no plumbago was produced in Ceylon and when the embargo was lifted the shippers were permitted to send forward only a certain proportion of what represented an average of their monthly shipments during the years 1912, 1913 and 1914. As the stocks of Ceylon plumbago in this country were practically depleted and shipments were inadequate to meet the demand, prices were advanced fully 50 per cent. However, on Sept. 1, the British government removed the embargo entirely

HORACE W. KNIGHT

and now shipments to this country are practically unrestricted.

When the embargo was lifted there were practically no stocks in Ceylon and fearing the possibility of an interruption in shipments, American buyers placed large orders for material with the result that prices were still further advanced. At the present time the demand is greater than the supply. It is stated that only one line of vessels is available for transportation to New York and only limited quantities of Ceylon plumbago will be accepted. The interruption of shipments through the Suez canal is expected and some vessels are taking the Cape of Good Hope route to this country. Several days ago an English vessel containing a large amount of plumbago was torpedoed in the Mediterranean with the result that the war risk insurance was further advanced.

Snyder Electric Furnace Installations

The use of furnaces for the production of steel by the electric process both for casting and rolling purposes, has made rapid strides during the past year. This is best reflected by the large number of furnaces installed and in the process of erection by the Snyder Electric Furnace Co., Chicago. During 1914 this company made two installations only, including the Otis Elevator Co., Buffalo, and the Crucible Steel Casting Co., Milwaukee.

The furnaces installed and in process of installation this year follow: A second furnace for the Otis Elevator Co., Buffalo, with a capacity of 30 tons in 24 hours; Niagara Electric Steel Co., North Tonawanda, N. Y., six tons in 24 hours; Gerlinger Steel Casting Co., Milwaukee, six tons in 24 hours; Dayton Steel Foundry Co., Dayton, O., 12 tons in 24 hours; S. Fair & Sons, Inc., Saginaw, Mich., six tons in 24 hours; Halcomb Steel Co., Syracuse, N. Y., 30 tons in 24 hours; Sivyer Steel Casting Co., Milwaukee, 12 tons in 24 hours; Electric Steel Co., Chicago, 12 tons in 24 hours; Haynes Stellite Co., Kokomo, Ind., 1½ tons in 24 hours; Thomas Davidson Mfg. Co., Montreal, 12 tons in 24 hours; Canadian Brakeshoe Co., Sherbrooke, Que., 20 tons in 24 hours.

The foreign contracts include orders for the Daimler Motor Car Co., Summerson & Sons, Ltd., and Thwaites Bros., Ltd., of England.

In addition, the company will install an experimental furnace in Chicago with a capacity of six tons in 24 hours. Two electric furnaces are being shipped to Chile and four furnaces are being installed for the production of ferro-silicon. The Chicago Bearing Metal Co., Chicago, recently placed its Snyder electric furnace in operation, which is utilized solely for the melting of brass

Electric Heat Blower

The B. F. Sturtevant Co., Boston, Mass., is manufacturing an electric heat blower, which consists of a small motor-driven fan, which discharges air from heating coils placed in an aluminum casing. The forced circulation renders it possible to deliver a large volume of hot air in a short time. The set is made in five different sizes and it delivers air at one, two or three temperatures, depending on the size. The fan outlet can be turned readily so as to discharge in any direction. The apparatus is portable and can be used in connection with any wiring system. In industrial establishments this small unit has a wide field of application.

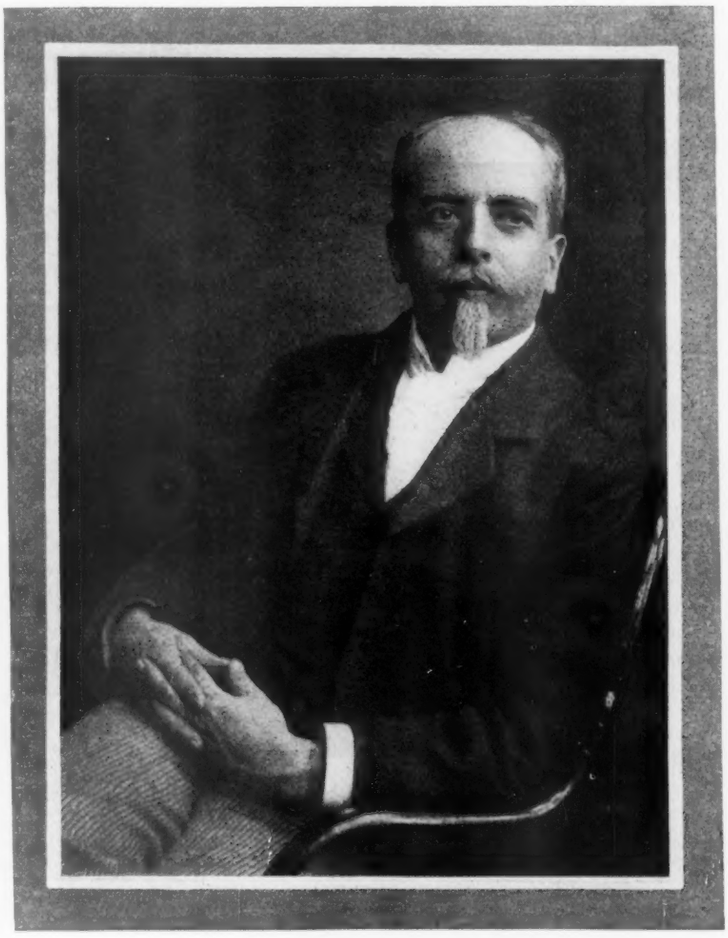
Death of James M. Dodge

James Mapes Dodge, chairman of the board of the Link-Belt Co., Chicago, died at his home, Philadelphia, Dec. 4. Mr. Dodge was one of the pioneers in the conveying and elevating art and to his inventive genius a large part of the development in recent years must be attributed. Mr. Dodge was born June 30, 1852, at Waverly, N. J., his mother, Mary Mapes Dodge having been a well-known author and for many years editor of the *St. Nicholas Magazine*, while his grandfather, Prof. James J. Mapes was a noted chemist and scientist. Mr. Dodge spent three years at Cornell university and a year at Rutgers college. After spending a short time at the Morgan Iron Works, New York City, he entered the shops of John Roach, ship builder, Chester, Pa., where he was successively appointed foreman and superintendent of erection. In 1876 he left the ship yard and after several years' experience in the east went to Chicago, where he formed the acquaintance of William D. Ewart, inventor of the Ewart system of link belting, and soon after he became associated with Mr. Ewart in the development of the chain business. Mr. Dodge's early work was confined principally to development and manufacture. New chains, new methods of manufacture and new conveying and elevating appliances were brought out in rapid succession. After this period of development, Mr. Dodge went east and entered into partnership with Edward H. Burr under the firm name of Burr & Dodge, who represented in Philadelphia the Ewart Mfg. Co., of Indianapolis. Out of this partnership grew the Link-Belt Engineering Co., organized in 1888, and after the formation of this company Mr. Dodge carried out his idea of development along strictly engineering lines.

In 1889, after becoming thoroughly acquainted with the needs of the anthracite coal industry, Mr. Dodge invented a system of storing anthracite coal in large conical piles and reloading it by machinery and accomplishing this result with little labor and practically no breakage. For this invention he was presented with the Elliott Cresson gold metal in 1907 by the Franklin Institute, Philadelphia.

Mr. Dodge was elected chairman of the board of directors of the Link-Belt Co., when it was organized in 1906 through the merger of the Link-Belt Engineering Co., Philadelphia; the Link-Belt Machinery Co., Chicago, and the Ewart Mfg. Co., Indianapolis. Among Mr. Dodge's other important inventions and improvements were those relating to the construction and manufacture of silent chain. While for many years a large employer of men, Mr. Dodge never was confronted with a strike or other labor difficulties. He was deeply interested in the personal welfare and advancement of his associates and he was a conspicuous leader in the general introduction of the best elements of scientific management. For many years he was closely associated with the late Frederick W. Taylor.

Mr. Dodge was a past president of the American Society of Mechanical Engineers; vice president of the Franklin Institute; trustee of the School of Design, Philadelphia, and received the honorary degree of doctor of science from the Stevens Institute of Technology.



JAMES MAPES DODGE

Book Review

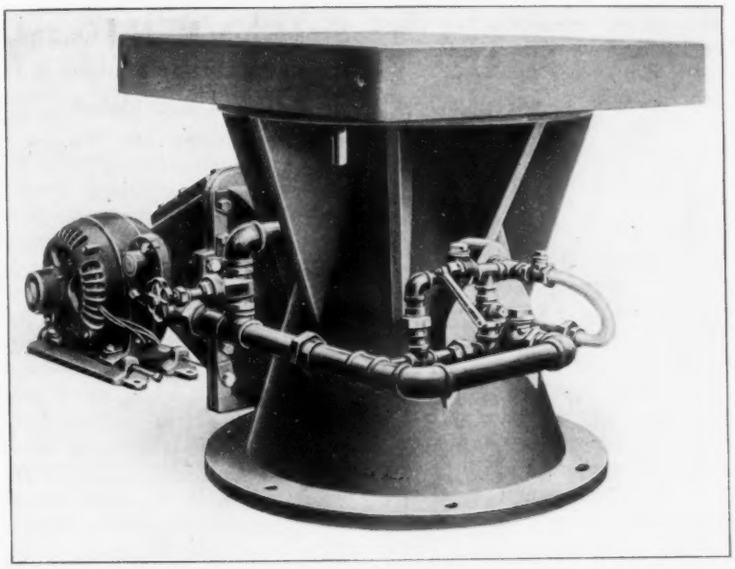
Galvanizing and Tinning, by W. T. Flanders; cloth; 350 pages; published by David Williams Co., and furnished by *The Foundry* for $3.00, postpaid.

This is a practical treatise on coating metals with zinc or tin by the hot dipping, electro-galvanizing, sherardizing and metal spraying processes. The book also contains information on the design, installation and equipment of galvanizing plants. The author is connected with the Malleable Iron Fittings Co., Branford, Ct., and has specialized in the hot-dipping processes for many years. He was aided in the production of this book by a number of specialists, including John Calder, Metals Coating Co. of America; R. D. Foster, Hanson & Van Winkle Co.; C. J. Kirk, U. S. Sherardizing Co.; A. F. Schoen, New Haven Sherardizing Co.; Louis Schulte, Ele-Kem Co.; William G. Stratton, R. N. Bassett Co., and Samuel Trood, consulting engineer. In the preparation of the book difficulties in obtaining definite data on methods and processes, many of which are patented and held as trade secrets, were overcome and the co-operation of influential men was enlisted for the common good of the trade.

The result is a comprehensive presentation of practically all branches of the art of placing protective coatings of zinc and tin on iron and steel products.

The initial chapter takes up corrosion and its prevention; this is followed by a description of a hot galvanizing plant and its equipment, the pyrometer, materials used in galvanizing, pickling, cleaning, hot dip process, and methods of handling various forms to be galvanized.

A description of the Schoop metal spray process also is presented to-



ELECTRO-PNEUMATIC JOLT-RAMMING MACHINE BUILT BY THE VULCAN ENGINEERING SALES CO.

gether with data on tinning malleable castings, wrought iron and steel, retinning, tinning gray iron castings, electro galvanizing and sherardizing.

Ample illustrations, principally line drawings, illuminate the text and present in graphic form much information as to equipment and handling.

An effort has been made to collect and present in readily accessible form the latest information as to coating processes and to answer questions arising in the minds of manufacturers seeking to adopt some process in their plants. The adaptability of the various methods to differing requirements is discussed and the way pointed out for making a correct choice.

Electro-Pneumatic Jolt-Ramming Machine

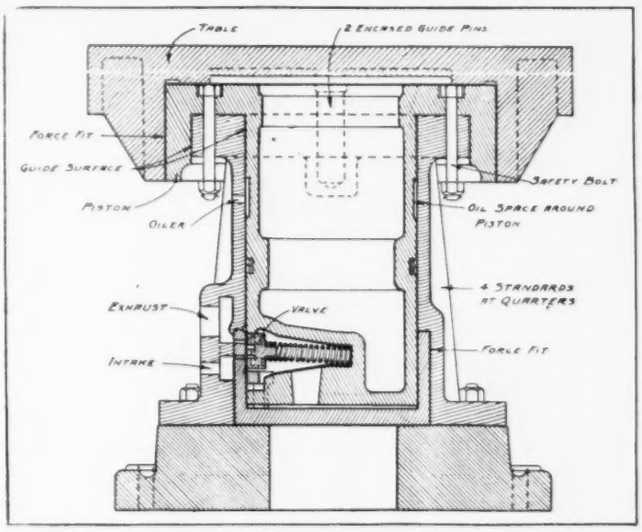
A jolt-ramming machine which embodies the air compressing unit for operating the ramming table is being built by the Vulcan Engineering Sales Co., Chicago. Air at atmospheric pressure enters the compression chamber of the machine, where it is compressed to the proper operating pressure by the forward movement of the piston. It then passes through suitable valve connections to the cylinder, raising the plunger to the table. During the upward travel of the plunger the exhaust port is opened and the high pressure air from underneath the plunger exhausts, allowing the plunger and table to drop to impact. The compressor piston then starts its return stroke, thus drawing free air through the check valve into the compression chamber, preparatory to compressing it on the forward stroke. The compressor is motor-driven and to start the jolting operation with the motor running constantly, it is necessary only to close the operating valve located between the compression chamber and the cylinder, thereby forcing the compressed air underneath the plunger. When the operating valve is opened, air at atmospheric pressure circulates through the machine with the action of the compressor piston, but is not compressed. The machine is driven by a double silent chain drive running in oil in an enclosed gear case.

Electric Steel Co. Organized

The Electric Steel Co., Chicago, has been organized to engage in the manufacture of small electric steel castings. A Snyder electric furnace will be installed in a plant acquired at Thirty-first and Wood streets, formerly operated by the Wildman Boiler Works. Power will be furnished by the Commonwealth Edison Co. from its high tension lines, which run underground, thereby insuring the least possibility of interruption. The officers of the company are Charles Piez, president, and P. L. Coonley, secretary and treasurer, who are, respectively, president and vice president of the Link-Belt Co., Chicago. This company has operated a Zenzes converter for a number of years. The active management of the company will be in charge of John M. Olmsted, vice president, who has been a member of the sales force of the Link-Belt Co. These three, with W. C. Frye and C. R. Messinger, will constitute the board of directors. Mr. Frye and Mr. Messinger are affiliated with the Sivyer Steel Casting Co., Milwaukee.

A New Jar-Ramming Molding Machine

A jar-ramming molding machine, which embodies new features of design and construction, is being manufactured by the American Molding Machine Co., Terre Haute, Ind., of which W. C. Norcross is president and general manager. Mr. Norcross has had a wide experience in the design, manufacture and operation of jolt-ramming machines in many casting plants throughout the United States and Canada, and has had unusual opportunities to investigate the operation of these machines under a variety of local conditions. A cross-section of this machine is shown in the accompanying illustration and it will be noted that the table has an unusually large direct support, imparted by the unique construction of the piston, which materially reduces the overhang of the table. The piston has a bearing on the outside of the cylinder flange in addition to the usual inside cylinder bearing, thereby providing an unusually large guide surface. The valve is a segment which works against the wall of the cylinder and is held seated by a spiral spring. The expansion of the valve spring com-



CROSS-SECTION OF JAR-RAMMING MOLDING MACHINE BUILT BY THE AMERICAN MOLDING MACHINE CO., TERRE HAUTE, IND.

pensates for wear and insures a permanent seat. It will be noted also that the bottom of the cylinder is enclosed by a tub casting, which is force-fit into the cylinder, eliminating the use of gaskets. Two guide pins completely encased and self-lubricated, prevent the table and piston from revolving.

This molding machine is oiled by a drop feed on the air line leading to the machine. It lubricates the lower end of the piston and the valve and through another oiler, which connects with the annular chamber in the piston, the top bearings are lubricated, as well as the enclosed guide pins.

Pouring Device

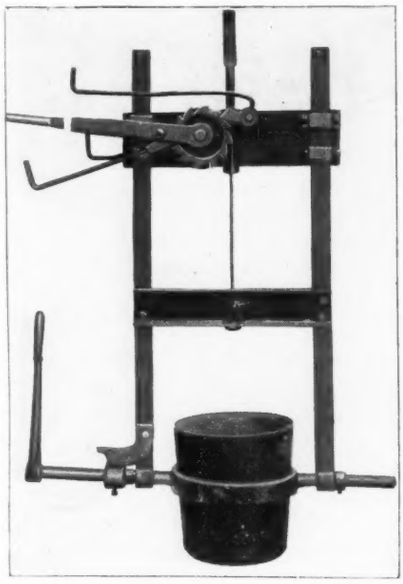
The Federal Foundry Supply Co., Cleveland, has developed a pouring device for shops specializing on light duplicate work, the details of which are shown in the accompanying illustration. The ladle is carried in a yoke constructed of bars and structural shapes, the various members being securely bolted together. The fixed portion of the device, which carries the adjusting drum and its accompanying pawl and ratchet mechanism, is suspended from a light, overhead crane or trolley. The movable portion or yoke, which holds the ladle, is supported by a wire cable. This cable is wound around a drum, which is controlled by the lever and ratchet arrangement shown in the illustration. This mechanism permits a vertical adjustment of 20 inches, thus enabling the device to be used conveniently in pouring molds of varying heights.

Finding Flaws by Electricity

An electrical device for the purpose of indicating differences in the homogeneity of metals of magnetic character, has been developed by Ethan I. Dodds, Pittsburgh. This apparatus is designed to record the location of internal defects in iron and steel castings, rails, ingots and the like. Numerous trials of this method of testing have been made at the plant of the Union Switch & Signal Co., Swissvale, Pa.

The device consists of two small horseshoe magnets. Each magnet has a primary winding, which is energized from the secondary coil of a transformer, the primary of which is energized by an alternating generator. The two primary windings of the magnets are connected in multiple. The secondary winding is connected with the terminals of two electro-magnets of a sound producing device or buzzer. The two buzzer armatures are tuned so that in harmony with similar currents in the windings of the magnets, they will produce sounds of substantially the same character. Adjacent to each buzzer armature is a transmitter, similar to that of an ordinary telephone.

In operation, a light magnetic current is induced through the product to be tested, the magnets being moved along its surface. As long as the metal adjacent to each magnet is of uniform character and density, approximately the same number of magnetic lines of force will pass between the two poles of each magnet, and sounds of corresponding character will be produced at the two sound producing instruments. It is pointed out that if there is a defect, such as a blowhole or pipe, the magnetic field of



POURING DEVICE CONTROLLED BY DRUM AND RATCHET

the magnet will be weakened to such an extent that less current will be induced in the secondary winding, thereby causing the sound producing instrument connected with this winding to produce a sound of different character from that of the other instrument, thus enabling the operator to locate the defect. A patent is pending on a machine developed by Mr. Dodds to register the variations in the currents.

Mr. Dodds is consulting engineer for the Flannery Bolt Co., Pittsburgh, and was the founder of the American Flexible Bolt Co. At one time he was connected with the Carnegie Steel Co. and the Pullman Co. He has made a comprehensive study of methods employed for the testing of iron and steel products.

Sand Mixing Machine Co. and American Foundry Equipment Co. Consolidated

The American Foundry Equipment Co., Cleveland, manufacturer of sand blast machinery, has been consolidated with the Sand Mixing Machine Co., New York City. The headquarters of the consolidated companies will be located in the Vanderbilt Concourse building, 52 Vanderbilt avenue, New York City, with a branch office in the Columbia building, Cleveland. The two companies, while allied, will continue to operate under their individual names. The Sand Mixing Machine Co. builds the auto sand mixer, which is employed for cutting sand in foundries, 225 of these machines now being in operation in casting plants throughout the United States. The American Foundry Equipment Co., of Cleveland, established by H. L. Wadsworth, builds a complete line of pressure system sand blast equipment and also designs and builds sand blast cleaning outfits for special purposes. The standard machines include an automatic sand blast tumbling barrel, automatic rotary table sand blast room, automatic sand blast cabinet and an automatic monorail sand blast outfit. A double monorail sand blast plant of this kind has recently been installed by the Aluminum Castings Co., Detroit. V. E. Minich, vice president of the Sand Mixing Machine Co., with headquarters in the Vanderbilt Concourse building, New York, will have charge of the sales and finances of the consolidated companies and H. L. Wadsworth, Columbia building, Cleveland, will be in charge of production and design.

Cutting of the Cupola Lining

By W. J. Keep

Question:—We are experiencing considerable difficulty due to the cutting away of the lining of our cupola when making nine-ton heats, although this does not occur when making five-ton heats only. The cupola is lined to a diameter of 36 inches and our first charge consists of 1,500 pounds of iron to 700 pounds of coke, while the balance of the charges consist of 1,000 pounds of iron to 120 pounds of coke, with the exception of the tenth charge, when 300 pounds of coke are used for the charge of 1,000 pounds of iron, after which the previous ratio is continued. This charge of coke is increased with the belief that it furnishes a new fuel bed for the remaining charges of iron. The charges consist of 700 pounds of pig and 300 pounds of sprues throughout

the heat. We also use 500 pounds of borings charged in tin cans, 400 pounds of steel punchings, 100 pounds of wrought iron pipe and 250 pounds of mill shot. The distance from the sand bottom to the lower part of the tuyeres is 12 inches and the fan has an outside diameter of 48 inches. What should be the blast pressure? After the third charge, 35 pounds of limestone are added to each charge of iron. No trouble is experienced in slagging the cupola. The furnace is lined with circular fire brick and the daubing consists of one part of kaolin to two parts of sand.

Answer:—After the kindling and wood are burnt out and the coke is well lighted and just before beginning to charge the iron, the coke should be leveled to a height of 15 inches above the tops of the tuyeres. This can be ascertained by measuring down from the sill of the cupola door when the cupola is empty and then measuring down to the surface of the coke. Weigh 1,000 pounds of bed coke, and after the bed is the proper height, the remainder that is left can be weighed and from this can be ascertained the required weight of the bed. Your coke and iron charges should not vary during the heat. Each charge should replenish the bed and 1,000 pounds of iron should require 100 pounds of coke. Good results can be obtained in melting borings by charging them in boxes made of 1-inch lumber, 100 pounds to each box. You state that your charges consist of 700 pounds of pig and 300 pounds of sprues throughout the heat and then you add that you also use 500 pounds of borings, 400 pounds of steel punchings, 100 pounds of wrought iron pipe and 250 pounds of mill shot, or 1,250 pounds total. You do not say, however, how or when the latter is charged.

Regardless of how you make up the charge, you should use 1,000 pounds of iron to each charge, with 100 pounds of coke. You will be obliged to use more coke when charging wrought iron, although 100 pounds would hardly be noticed. Also, you failed to state whether the 500 pounds of borings are cast iron or steel. They should not be mixed, that is, you should know what you charge. Distribute whatever you use as needed for your particular castings, but systematize the operation of the cupola. Do not use more limestone than is required to make a fluid slag and to insure a satisfactory drop, twenty pounds of limestone being sufficient. An excess of lime must find silica and alumina and it obtains this from the lining. A depth of 4½ inches is sufficient for the tuyeres, but a width of 6 inches is not satisfactory.

Make the tuyeres as nearly continuous as possible on the inside of the lining, and we would suggest a size of 4 x 12 inches. Make the entrance from the wind box 6 x 6 inches. A large tuyere area does no harm, as it will not direct the blast against the opposite side of the lining. Your six tuyeres should be spaced equally all around the inside diameter of the furnace except at the slag hole, where they can be located wider apart to prevent chilling the slag. Use your fan as you have it and about 14 ounces blast pressure should be noted at the middle of the heat. The wrought iron pipe which you charge should be crushed flat and then cut into pieces not more than 6 inches square. If you follow the foregoing suggestions you should obtain better results than in the past.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

S. Fair & Son, Saginaw, Mich., iron and steel founders, have increased their capital stock from $20,000 to $75,000.

The Globe Stove & Range Co., Kokomo, Ind., has increased its capital stock from $500,000 to $600,000.

The Columbia Castings Co., Detroit, has increased its capital stock from $30,000 to $100,000.

The plant of the Eagle Castings Works, Winchester, Ky., has been taken over by James Love, Lexington, Ky., under lease.

The Richmond Brass Foundry Co., Richmond, Cal., has taken over the old Santa Fe foundry and will open it shortly.

The Elwood Foundry Co., Indianapolis, Ind., has been incorporated with a capital stock of $10,000 by E. C. Scotten, B. H. Campbell and Lewis A. Coleman.

J. M. Leach, 47 Union avenue, Portland, Ore., who operates a machine shop, will move to Union avenue and Yamhill street and will install foundry equipment.

The Waterbury Brass & Bronze Bearing Co., 115 Maple street, Waterbury, Conn., has been organized by Henry L. Silver and Henry W. Even to engage in the manufacture of brass, bronze and aluminum castings, bearings, etc.

The Federal Brass Co., Ltd., Montreal, Que., Can., has been incorporated with a capital stock of $50,000 to engage in the refining and casting of brass. The incorporators are Joseph P. A. Belanger, Louis J. C. Gagnon and Joseph E. A. Blais.

The Mal-Gray Castings Co., Cincinnati, O., has been incorporated with $50,000 capital by Thomas P. Greenhow, J. W. Brown, F. M. Whittlinger, W. B. Portlage and H. M. McLean.

The Romeo Foundry Co., operating plants at Romeo and Port Huron, Mich., has bought the old plant of the Havers Motor Car Co. at Port Huron and is remodeling it for a third foundry.

The plant of the St. Albans Foundry & Implement Co., St. Albans, Vt., has been remodeled and leased to the Foundry Motor Car & Mfg. Co., Inc., a new automobile concern.

The Ideal Foundry & Hardware Co., Ltd., Toronto, Ont., Can., has been incorporated with a capital stock of $50,000 by Arthur E. Furniss, Robert M. Yeomans and Bertram Macdonald. The new company will take over the business of the Imperial Foundry Co.

New Construction

The Connor Foundry Co., Grand Rapids, Mich., will build a one-story addition.

Work has been started on the erecton of a one-story, 120 x 400-foot addition to the foundry of the General Railway Signal Co., Rochester, N. Y.

The Schneider-Bowman Co., Philadelphia, will build a two-story, 18 x 76-foot brick addition to its foundry.

The Crosby Co., Buffalo, N. Y., is erecting a one-story foundry addition, 30 x 125 feet.

The Homer Furnace Co., Homer, Mich., will build a foundry addition to its plant.

C. Cowles & Co., New Haven, Conn., have started work on a new brass foundry.

The Welch Mfg. Co., Sparta, Mich., is erecting a foundry.

Wasner & Wilkie, Batavia, O., will extend their foundry.

The Dominion Bridge Co., Lachine, Que., Can., is erecting a brass foundry at a cost of $20,000.

The Illinois Malleable Iron Co., Chicago, will build an addition to its plant at a cost of $7,000.

The American Foundry Co., Indianapolis, Ind., contemplates erecting a small addition to its plant.

The Williamson Heater Co., Oakley, Cincinnati, will erect an addition to its foundry.

The C. A. Danberg Co., New Britain, Conn., will be incorporated to engage in the operation of a brass foundry. A plant is now being erected. The incorporators will be Charles A. Danberg, Emil J. Danberg and Mrs. Anna Danberg.

The Standard Steel Co., Montreal, Que., Can., recently incorporated with a capital stock of $200,000, has taken over and will

enlarge a foundry on Atlantic avenue. Steel castings will be made.

The Belle City Malleable Iron Co., Racine, Wis., is erecting a foundry 80 x 320 feet.

The Holt Mfg. Co., Peoria, Ill., will build a gray iron foundry with a daily capacity of 100 tons.

Bids are being taken on a 40 x 90-foot addition to the foundry of the Crucible Steel Casting Co., Milwaukee.

Work has been started on a one-story, 30 x 100-foot foundry for the Catchpole Boiler, Foundry & Machine Co., Geneva, N. Y.

The contract has been awarded for a one-story, 36 x 40-foot addition to the plant of the Fitchburg Foundry Co., Fitchburg, Mass.

The Lakey Foundry & Machine Co., Muskegon, Mich., will build an addition to its plant which will double the capacity.

The Fox Typewriter Co., Grand Rapids, Mich., contemplates erecting a foundry, 90 x 300 feet, at a cost of $30,000.

The Hudson Foundry Co., 294 West Thirteenth street, Chicago, is building an addition to its foundry, costing $3,000.

The American Car Wheel Co., Pittsburgh, contemplates erecting a foundry for the manufacture of cast iron car wheels.

The Stafford Co., Readville, Mass., will build a two-story, 184 x 185-foot brick addition to its foundry and storehouse.

The Ashcroft Mfg. Co., Bridgeport, Conn., is building a one-story, 27 x 61-foot addition to its foundry.

The Fay-Kultgen Foundry Co., St. Joseph, Mich., is building an addition to its plant.

The Detroit Steel Casting Co., Detroit, will erect an addition to its plant at a cost of $2,200.

The Plymouth Motor Castings Co., Plymouth, Mich., is rebuilding its plant recently destroyed by fire.

The Doehler Die Casting Co., Toledo, O., has brought a site on Smead and Lincoln avenues on which it is erecting a $300,000 plant.

The Chicago Nut Co., 2513 West Twentieth street, Chicago, manufacturer of brass nuts, will build a two-story foundry costing $38,000.

The American Steel Foundries, East Chicago, Ind., will erect a one-story addition, 178 x 300 feet, at 138 street and Michigan avenue.

The Klauder-Weldon Dyeing Machine Co., Amsterdam, N. Y., which will move to Yardley, Pa., has awarded the contract for a one-story foundry, 78 x 111 feet.

Plans have been prepared for a 114 x 200-foot addition to the plant of the Elmwood Castings Co., Cincinnati. Another addition also will be erected.

The Jaeschke Bros. Foundry Co., 3026 Locust street, Milwaukee, will erect a foundry and pattern shop at Cawker place and Thirtieth street costing approximately $17,500.

The Seaman-Sleeth Co., Pittsburgh, is erecting an office building and is increasing the capacity of its foundry for the manufacture of rolls.

The United States Cast Iron Pipe & Foundry Co., Chattanooga, Tenn., will build an addition to its plant for the manufacture of flanged pipe and fittings.

The Union Iron Works, San Francisco, will remodel its foundry and build a floating dry dock and other additions to the plant at a cost of $1,000,000. John A. McGuire is president.

The Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa., will extend its plant by the erection of a building, 60 x 240 feet. Sand-cast and chilled rolls and alloy rolls in all sizes will be manufactured in the new plant. Its equipment will include two cupolas, two air furnaces of 30 and 10 tons capacity respectively, roll pits, drying ovens, annealing furnaces and 30 and 10-ton electric cranes. The capacity of the new foundry will be from 600 to 800 tons of rolls per month.

The Buckeye Foundry Co., Cincinnati, O., will erect a foundry on Buck street, near Harrison avenue. The building will be 50 x100 feet, of brick and steel construction and will cost approximately $7,000.

Plans are being prepared for a rolling mill and foundry to be erected for the American Cupro-Nickel Co., Stamford, Conn. The mill will be 113 x 180 feet and the casting shop 45 x 125 feet, both of brick construction.

The Electric Steel Casting Co., Milwaukee, has been organized by Leo G. Smith, former manager of the Prime Steel Co. of that city. With Mr. Smith will be associated two former employes of the Prime Steel Co., namely F. G. Wetter, purchasing agent, and C. F. Taylor, of the selling force. The officers of the new company are Leo G. Smith, president; Chauncey W. Yockey, vice president and general counsel; F. G. Wetter, secretary and purchasing agent, and C. F. Taylor, treasurer. The company will engage in the manufacture of electric steel castings. A building, 80 x 500 feet, of reinforced concrete, brick and steel will be erected. A three-ton electric furnace will be installed.

The Maiwurm Aluminum Co., Pittsburgh, has been incorporated in Delaware with a capital stock of $1,200,000. The new company contemplates operating an aluminum cooking utensil plant and a smelter for the reduction of bauxite. Work on a new plant will start shortly and it will be equipped with machinery especially designed by Paul Maiwurm, founder of the company, who now owns a utensil plant at Ashland, O. Mr. Maiwurm is president and general manager of the company and Edward A. Nisbitt, with offices in the Farmers Bank building, Pittsburgh, is secretary.

The Lima Steel Casting Co., successor to the Crucible Casting Co., Lima O., is building an addition, 80 x 160 feet, and is installing a side-blow converter. The present method of melting, which is by the crucible process, will be discontinued. The plant will be ready for operation in the near future. Recently the capital stock of the company was increased from $50,000 to $100,000. The officers are: President, B. F. Thomas; vice president, W. C. Bradley; treasurer and manager, M. L. Johnson, and superintendent, John Sonnenfeld.

NEW TRADE PUBLICATIONS

CONVEYING EQUIPMENT. — The noiseless pivoted conveyor for handling coal, ashes, coke, etc., manufactured by the C. W. Hunt Co., Inc., West New Brighton, N. Y., is illustrated and described in a 52-page catalog. The object of the catalog is to suggest to those operating or designing a power house, the advantages and obvious economies possible with a properly arranged coal and ash handling plant. The catalog contains not only detailed illustrations of the conveyor, but numerous installation views in various large plants throughout the country.

JOLT-RAMMING MACHINES. — The extensive line of jolt-ramming machines manufactured by the Mumford Molding Machine Co., Chicago, is illustrated and described in a 12-page bulletin. These machines are built in various sizes for different classes of work, ranging in table sizes from 15 x 20 inches to 84 x 168 inches, and have lifting capacities at 80 pounds air pressure from 350 to 3,900 pounds. The sizes of the cylinders also vary from 3 to 32 inches. The pamphlet is well-illustrated and contains considerable interesting information on jolt-ramming molding machine operations.

OVERHEAD CARRYING TRACKS.—The handling and conveying of material in industrial plants by overhead carrying tracks is illustrated and discussed in a 64-page catalog issued by the Coburn Trolley Track Mfg. Co., Holyoke, Mass. This work is printed in two colors and is unusually well-arranged. The track is of the round, trough type and is made in three sizes for varying loads. These overhead systems are used to advantage in foundries for the handling of metal, for conveying coal and ashes, for the handling of castings and other heavy metal parts in machine shops and in other industrial plants where materials must be conveyed from one part of the plant to another. In addition to the round trough trolley tracks an I-beam system also is furnished and it has been installed and is operated successfully in many foundries. In addition, the Coburn Trolley Track Mfg. Co. builds swivel carriers in various capacities, switches for overhead systems, electric hoists, pneumatic geared hoists, tipping buckets, telescoping hoisting device for ladles, jib and hand power cranes, plain and geared trolleys, turn-tables, etc.

CORKBOARD INSULATION.—Corkboard insulation, which is used to advantage in the form of cork brick for insulating various types of furnaces, ovens, boiler settings, etc., is illustrated and described in a 144-page catalog issued by the Armstrong Cork & Insulation Co., Pittsburgh. The work is interesting from many viewpoints and is more than a trade catalog in view of the fact that it contains a number of pages devoted to the obtaining of the raw material. The tests recorded, which were scientifically conducted, prove that the material accomplishes what is claimed for it. Probably one of the most interesting sections of this work includes the specifications for the erection of corkboard and brick in walls of various types of ovens, furnaces, etc. Cork insulating brick combine low heat conductivity with sufficient strength to enable them to be built-in as a part of the structure which they are designed to insulate. The brick are composed of diatomaceous earth and finely ground cork molded into brick form and then fired. The cork thus is burned out, leaving the brick extremely porous in texture and a light terra cotta in color. They transmit actually one-tenth as much heat as fire or common brick. It is claimed that a single course of insulating brick, 4½ inches thick, is equal to 45 inches of fire or common brick in insulating value. The Armstrong company operates factories at Beaver Falls, Pa.; Camden, N. J.; Oakdale, Pa., and Seville, Spain. The latter works are devoted entirely to the manufacture of high pressure pipe cork covering.